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Teacher's Manual for

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A TEACHER'S MANUAL
AND SCIENCE HANDBOOK

to accompany

**WE SEE
PRE-PRIMER**

of the

HOW AND WHY SCIENCE
SERIES

Prepared by

HELEN DOLMAN MacCRACKEN

and

LOIS GABEL ARMSTRONG

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THE L. W. SINGER COMPANY, INC. ·

Syracuse, New York



THE HOW AND WHY SCIENCE BOOKS

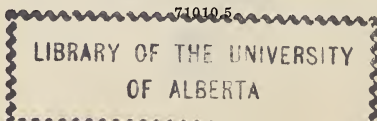
WE SEE (PRE-PRIMER)
SUNSHINE AND RAIN (PRIMER)
THROUGH THE YEAR (GRADE 1)
WINTER COMES AND GOES (GRADE 2)
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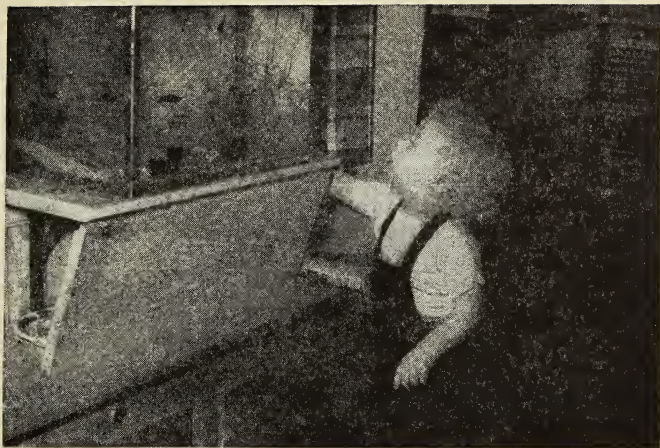
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Printed in the United States of America





"All knowledge begins in wonder."

ELEMENTARY SCIENCE

THE PHILOSOPHY OF SCIENCE TEACHING

Someone has said, "All knowledge begins in wonder." A child entering school for the first time brings with him spontaneous enthusiasm and interest in the world about him which manifest themselves in an eagerness to relate his experiences. He is full of questions about the caterpillars, frogs, turtles, and other live things that he finds as he plays. He is curious about the weather, the heavenly bodies, and other physical phenomena of his environment. He asks how and why the mechanical devices of his everyday experiences work.

Too often this natural curiosity of the little child is lost instead of being developed during the first few years of school life, because teachers and parents feel their inadequacy to meet the situation. The knowledge required to answer all these questions is so great as to discourage the average adult. When children are curious, they have no respect for the lines of subject matter. One question may fall in the field of biology; the next in physics or chemistry. To

answer all questions completely might well require more knowledge than even a specialist would possess.

However, to teach science to children it is not necessary to be able to answer all their questions. The alert teacher with abundant enthusiasm and curiosity can help them find the answers to many of their own questions. Nowhere will her efforts bring more satisfying results than in the teaching of science.

The philosophy of science teaching differs very little from that of any other subject. It is the subject matter which makes the handling of it more difficult, because teachers are not generally trained for science teaching. The teacher must take into account those things in the child's experience which lie in the field of science. There are many experiences common to children everywhere that may become the foundations of our science work. From these common paths teachers may diverge with the interests of individuals and the groups, and adapt the teaching to the local community or section of the country.

We live in a world that is changing so rapidly that what is grist for the science mill today may become a waste product tomorrow. One day a Byrd explores Antarctica; a Beebe explores the depths of the ocean; or a Piccard penetrates the stratosphere. At such times even first-graders may discuss the stratosphere but to put the stratosphere into a first-grade book, in the light of our present knowledge, would be questionable.

Again, the children we teach are affected by varied environments. Those of the western plains have a whole set of animal concepts not possessed by children of the Atlantic coast. Children in a mining town, children from the country, children from a metropolis—all have experiences which give them different ideas. But through all these experiences the teachers may teach the same scientific principles. For example, hibernation of animals may be taught to a western child by a study of snakes; to a child in the lake region by a study of frogs; to a child somewhere else by the study of clams, crayfish, or some insect.

In science, the teacher needs to remember individual differences. Some children respond more freely to experiences with plants, some to animals, some to physical science. By encouraging children to express themselves freely in the classroom, and to experi-

ment for themselves with the materials found in the science room, the teacher can discover these differences and make effective uses of them.

Above all, to be a successful teacher of science, one must be enthusiastic about the subject, enjoy working with children, and understand the way they think. She must be scientific in her own attitudes and be able to use the problem-solving method of teaching. She does not have to be a specialist in science nor be afraid that she won't know all the answers. She probably won't be able to answer all the questions which the children ask, but even if she can, to do so would spoil the fun for the children. She need not hesitate to say, "I don't know," providing she continues, "but we'll find out together." Science teaching can be a shared experience of teacher and children that has great possibilities for both.

OBJECTIVES FOR TEACHING SCIENCE TO CHILDREN

Science for the grades should not be regarded as a mere accumulation of facts but as a series of experiences with the science materials that are a part of every child's daily life. These experiences stimulate the curiosity of children and if used properly should lead to behavior changes in the children. To accomplish desirable outcomes the teacher should understand the reasons why anyone studies science. These reasons may be called objectives. Scientists differ in the way they state these major objectives, but they agree on their content. Briefly stated, these objectives of elementary science are:

1. To develop an intelligent appreciation of the natural and physical world.
2. To develop scientific attitudes.
3. To help the child acquire the scientific method of problem solving.
4. To help the child acquire useful knowledge of scientific principles.

By an intelligent interest and appreciation of the world in which he lives, a child is made aware of real beauty that goes deeper than

the mere appeal to sense. Appreciation grows as knowledge is gained. The person who gets a satisfaction from the color and form of a beautiful butterfly should enjoy it more after seeing it go through its transformation from pupa to adult. The child who, looking intently at a butterfly's chrysalis, exclaimed, "Oh, I can see the wings through the chrysalis skin!" was experiencing appreciation. Children should get a thrill out of their science experiences which will make their lives richer and more enjoyable.

Appreciation should lead to the conservation of wild life. The biological principles of the struggle for existence and survival of the fittest make for a balance in nature, unless it is upset by man. Through experiences with material such as that used in "Insects in the Garden," "Birds in the Orchard," and "Life in the Pond," children may be led to see the relationships of plants and animals. They learn which ones are harmful, and what to do about them, as well as which ones are helpful to man.

The second objective, that concerning scientific attitudes, should run through all science teaching. The child who has these scientific attitudes:

- (a) Will have a conviction of basic cause-and-effect relation which will make it impossible for him to believe in superstition or unexplained mysteries.
- (b) Will have a sensitive curiosity which will lead to making accurate observations, collecting data, and searching for adequate explanations.
- (c) Will have the habit of delayed response, preventing him from making snap judgments or jumping to conclusions.
- (d) Will weigh evidence carefully to find out if it is sound, pertinent, and adequate.
- (e) Will have respect for another's point of view, being willing to change his point of view in the face of new evidence.

These may sound formidable to the teacher who has had little training in science. She may recognize them as desirable outcomes, yet not have the slightest idea of how to go about teaching them. She need not be frightened, however, because the techniques by which she helps children develop scientific attitudes are

very similar to those she uses to develop social attitudes. The first step is to be able to recognize a *lack* of the attitudes.

For example, a child who says, "My grandmother says the ground hog saw his shadow and he can tell about the weather," does not have the attitude of looking for a cause. The teacher could help him develop the attitude by saying, "That is interesting. I wonder what makes your grandmother think that," or, "I wonder what the ground hog (woodchuck) knows." The child may answer, "If he sees his shadow on ground-hog day, we'll have six weeks of bad weather." Then the teacher may say, "That may be true, but what do the rest of you think about it?" After a brief discussion she may say, "All of you are just giving ideas. Is that the way scientists (or people who study woodchucks) would settle a question?" The children may suggest watching for woodchucks or discussing the weather on February 2—will the woodchuck see his shadow or not? They may watch the weather for six weeks, recording it and comparing the actual weather with the woodchuck's "prediction." Some child may be bright enough to remark, "It may be cloudy in the fields south of town and the sun may be shining on the north side. The north side couldn't have six weeks of bad weather while the south side is having good weather." The grandmother (who would have resented it had the teacher said, "That idea is not true, Tom,") may become interested in a long-time experiment; but, whether or not there is hope for grandmother, Tom's plastic mind has been affected by six weeks of observing and checking.

Later when Dick insists that horsehairs turn into snakes, Tom will be eager to bring rain water and a horsehair to find out if Dick is right. Bit by bit, these experiences will straighten out Tom's thinking until one day he will say, "I don't believe in superstitions. One day when we were out driving, a black cat ran across the road. Later we had engine trouble, but the trouble was caused because a part had worn out."

Not only is this attitude taught by correcting existing superstitions and misconceptions, but it impels children to look for the causes of all natural phenomena. Numerous opportunities arise every day to develop it. For example, in trying to solve the problem of why food spoils, the teacher may ask, "Where does your



Independent investigations.

mother put food that she wants to keep?" Through discussion someone may say, "Temperature will affect food. When food gets hot, it spoils." In problem solving there are many opportunities to teach scientific attitudes.

The ability to interpret natural phenomena correctly does away with unreasoning fears. The child who understands the cause of thunder, and has demonstrated it in a small way by clapping his hands, is not so likely to be afraid of the noise. Knowing that animals are not likely to sting or bite except in self-defense, he is less susceptible to the fear carried by many people into adult life. The person who has studied about meteors and northern lights doesn't assign mysterious reasons or results to these natural phenomena. The child's understanding of the cause and prevention of disease helps keep him from carelessly exposing himself and others, as in the case of colds. He learns that everything has a cause; that disasters don't just happen, nor, as was once believed, are they visited upon us as punishment.

Curiosity concerning their environment is natural to children, though some have more of it than others. But sensitive curiosity may have to be taught. Children ask many questions to which they really don't expect an answer, nor care for one. Sensitive

curiosity is demonstrated by a perseverance on the part of the child in asking a question, or in independent investigation on his own initiative. Children should be given opportunities to tell of things they observe that stimulate their interest and curiosity. If learning is dependent upon desire to know, then curiosity is a valuable attitude to develop. Some children have it to such a degree that no amount of squelching on the part of adults will stop their investigations. They learn in spite of their teachers. Other timid ones stop asking when they get no satisfactory explanation. The child who persisted in saying, "I *want to know* what makes the bubbles in cake," after the teacher had told her it was too hard for her to understand, had unquenchable curiosity.

The ability to make careful, accurate observations and the ability to collect data are outcomes of the attitude of sensitive curiosity. Some teaching techniques which help in the teaching of this attitude are:

- (a) Making use of the children's suggestions of ways to collect data—for example, when Mary wonders what will happen if a prism is held in a cloud of dust while a sunbeam is striking it, let Mary try it, using chalk dust.
- (b) Insisting upon accurate descriptions when a child reports having seen something—for example, when a boy describing an insect the size of a gnat, tells of a yellow stripe around its body, the teacher may say, "Just a minute. How could you see the yellow stripe on an insect no larger than a gnat? Tell just what you saw. If you didn't see the color, don't tell about it."
- (c) Setting an example of collecting data by asking questions about many points which the children have not mentioned in their descriptions.
- (d) Insisting upon experimentation or demonstration being directed to the purpose of gaining adequate explanations. Children are likely to become more interested in the working of the apparatus than in the answer to their original question. Then the teacher may say, "Why are we doing this experiment? Is it helping to answer the question? It is an experiment only as long as you are learning. After that it is play."

The attitude of delayed response is developed by insisting on the children's not "jumping to conclusions." The child who says, "I saw a bird. I *think* it was a woodpecker because it was tapping on a tree," or "I *think* the fish died because we didn't put any green stuff in the aquarium like we do at home," or "I'm *not sure*, but I don't think the air does all of the work of holding the plane up," has developed the attitude. The child who says, "I *know* that was a fallen star. There are a lot of them around here," hasn't developed the attitude.

To help develop the attitude of delayed response, the teacher must be on the alert with answers such as:

"We must be careful and not think we have found out something when we really haven't."

"Do you think you should say they are fallen stars? Has anyone proved it?"

"Let's save that question and answer it later. Then we will find out more about it to help us be sure." (And don't forget to do it!)

Having developed the attitudes of basic cause and effect, sensitive curiosity, and delayed response, children are ready for weighing evidence. Children are usually eager to express their ideas without thought as to whether they are pertinent or sound. When the teacher is just starting her science program, she may encourage expression to get things under way. After the ice is broken and the children are no longer inhibited or shy, the teacher has to curb their enthusiasm and direct their thinking.

To do this without breaking their line of reasoning takes skill. The teacher must not be discouraged if her first attempts at developing attitudes result in confusion. She may have to go back to the beginning of the lesson and start over. When this happens, the teacher should take the children into her confidence by smiling and saying, "I guess I got us off on the wrong track. Let's see where we were," or "We're all mixed up. You'll have to help me. What were we trying to find out?" The children will respond to this.

Some ways to help develop this attitude of weighing evidence are to give suggestions like:

"Let's remember not to take too much time with details that don't really have anything to do with our problem."

"Does your question have anything to do with electricity? Have you thought it through?"

"Do you think that we have enough information to answer the question?"

"Should we decide before we know what a scientist has to say about that?"

"Let's keep our minds on one track."

By consulting an authority, the teacher should check often on the accuracy and soundness of the experiments being done. The children should check with their science text. They should never draw conclusions from one experiment.

A child who has developed this attitude will say things like this: "I think the tooth comes from the upper jaw by the way it curves. If you'll look at a dog's teeth, you'll notice that the upper teeth curve down over the lower teeth. It's hard to tell whether it's the upper tooth of a big bear or the lower tooth of a small bear," or "We haven't read it carefully enough. He forgot to use a marker so I don't think it would be right."

Willingness to change one's opinion in the face of new evidence is the most advanced attitude of all. The person who has it is tolerant, without prejudice and bigotry. If all the children in the world could really be taught this attitude so that it would function, wars would cease. Science has no monopoly on this attitude, but it offers an excellent opportunity for its natural development. In social studies areas, emotions are more likely to be involved. In solving science problems, children can be more objective. The teacher may say:

"There is a sentence on that page that isn't exactly scientific. Scientists have found out more about it since the book was published."

"When one has the floor, let's remember that others want to talk also, and not take too much time."

"Don't laugh. I'm not surprised that he's mixed up. Grown folks get mixed up, too."

"Do we laugh at people who have ideas?"

"Let John have his chance. Let's listen to what he has to say."

"I think he has an idea, but it just isn't very clear."

"Evidently there are three people who do not agree."

"Jane listened to you; now it is her turn."

Allow every child an opportunity to tell one thing he has observed or learned from an experiment. Give careful consideration to every child's serious question or attempt to explain something. If the teacher respects children as individuals, respects the importance of their problems, and is willing to change her own mind when she sees that she is wrong, it will help in teaching this attitude.

The child who has this attitude will say, "I don't quite agree with her because I think there is a change in the temperature of the land," or "I thought the candle wick burned, but now I know that it is the gas that burns."

Children often have pretty definite ideas about their experiences and are not willing to change those ideas. For example, many people use widely advertised products in their homes without investigating their true value. One science group made a study of some of these products and discovered that the advertising was misleading. The children in the group were learning to evaluate and test statements in the light of evidence.

Willingness to change opinion, to search for the whole truth, and to base judgment on fact are all closely related and may be developed together. They may all result from a comparison of experimental data or accurate observations.

A child may have formed some incorrect idea that he has heard or read in a book. For example, a child insisted that "beavers carry mud on their tails" because he had read it in a children's storybook. The other children challenged his statement. The teacher asked how they could know whether or not the statement was correct. The children said to ask a scientist or look it up in several books written by scientists who had studied beavers. When this was done, the child who had made the statement saw that his idea was wrong. He also realized that he could not believe everything he read.

TEACHING PROBLEM SOLVING TO CHILDREN

Many elementary teachers have themselves not had the advantage of science training and do not know how to teach by the problem-solving method. Although it is not unique to the field of science, the average elementary teacher may not have learned the techniques necessary to help children learn it and use it. Even if teachers have used problem solving in teaching social studies or arithmetic, unfamiliarity with the science fields may make them hesitate to apply it in that area. Yet science problems are such a natural part of every child's world that the questions he asks are the easiest approach to the development of these particular skills and habits. Since educators agree pretty uniformly that our major objectives lie in the areas of appreciations, attitudes, skills, and habits rather than in subject matter as such, the training of children in the problem-solving method seems very important.

The first thing that a teacher must do before starting to help children learn problem solving is to be able to recognize good problem situations and good problems. Among the questions that children ask are many that are of passing interest and may be answered quickly and easily. But often some of these questions offer opportunities for real problem solving.

For example, a group of first-graders, during their science meeting were reporting their observations of natural happenings. Some of the questions about an icicle that one child showed were:

1. Can you see through that ice?
2. Why is the ice frozen around the stick?
3. Would it freeze again if we put it out today? (The icicle was melting.)
4. How was the icicle made?

The teacher recognized number four as a good problem to help the children start developing some skills, so she used it. The other questions were used in developing the problem.

Some of the things to keep in mind when selecting a problem from children's questions are:

1. Is it suitable for the age level of the child who is trying to solve it?

2. Is it worth spending time on?
3. Are the materials available with which to solve it?
4. Does it offer opportunities for many child activities?
5. Are the children interested in it?
6. Can it be solved within the interest span of the group?
7. Does it contain the elements that make it a real problem to the children?

To illustrate these criteria let us test the problem, "How was that icicle made?"

With a group of children who had had no previous experiences with ice, the problem might have been too difficult. To know this a teacher needs to analyze the problem for the concepts necessary to its understanding. Some of these concepts in this case are:

1. Ice is frozen water.
2. Water freezes out of doors in winter.
3. Heat melts ice.
4. Sunlight gives heat.
5. Snow is frozen water.

The first grade which asked the question about the icicles had developed these concepts in the kindergarten, so this problem was suitable for their group. The problem might have been just as suitable for a fifth or sixth grade which had not had the science experiences of this first grade.

Testing the problem by the second criterion, "Is it worth spending the time on it?" one might say that it isn't very important to know how icicles are formed. Certainly many adults are leading happy, useful lives without the knowledge. We can't justify the value of the problem by the knowledge objective.

From the standpoint of appreciation, icicles are beautiful. That is one reason they attract children. Icicles are also interesting and arouse curiosity. Curiosity, if properly directed, leads to the scientific attitude of sensitive curiosity. Besides these values, the fact that the children are trying to find an answer to their own question makes it an ideal way to develop problem-solving skills.

The third criterion, "Are there materials available with which to solve it?" is satisfied, since in winter we have temperatures for simple experiments with freezing. The fourth criterion, "Does it

offer opportunities for child activities?" is met in that all of the experiments, demonstrations, and observations needed for solution are easily done by six-year-olds. It satisfies number five, "Are the children interested in it?" because the children initiated the problem.

Criterion number six, "Can it be solved within the interest span of the group?" is satisfied at whatever age level we are solving the problem. In the first grade which raised this problem the interest span was rather short. The group met with the science teacher only once a week for a twenty-minute period. Yet for two or three weeks the children kept bringing icicles of different sizes and shapes to the science room, commenting upon them in such a way as to demonstrate an understanding and an appreciation of their formation. Of course their understanding was not as complete as that an older group would have, but as far as it went it was correct.

To check with criterion number seven, "Does it contain the elements of a real problem?" we must analyze what we mean by the elements of a good problem. Why is "How was that icicle made?" a good problem while "Can you see through the ice?" isn't so good?

In the first place, a problem must present an obstacle in thinking. "Can you see through the ice?" presents very little difficulty because to answer it the child merely holds the ice up and tries to look through it. There is no need for the problem-solving technique. The other question cannot be answered so readily. Unless the children have already met the question before and had it answered, they must discuss it and give possible answers based on their previous experiences. Then they must test these possible answers in various ways, finally drawing conclusions from the results of their data. True, this will be done very simply in the first grade, but by repeated learning situations of this kind even six-year-olds begin to develop these skills and habits.

Elementary teachers often say, "It is all very well for a science teacher to talk about these methods of teaching science to children, but theory and practice are two different things. We have to teach the children." Elementary teachers are justified in this criticism. Too often college teachers have a tendency to deal with

ideas and theory, neglecting contact with practical teaching situations.

For that reason let us examine several actual problem-solving lessons as taught at different grade levels, for the teaching skills needed to teach them.

The first one was taught in a first grade, and used only the materials of the environment. The problem was child-initiated when there was a hard rain and the children found earthworms on the sidewalk.

PROBLEM: Why do earthworms come out of the ground when it rains?

ANALYSIS:

Teacher's questions—

1. Where do earthworms usually live?
2. What must live things have in order to live?
3. What ideas do you have about why you found the earthworms on the sidewalks?

Hypotheses or possible answers given by the children were—

1. Maybe the earthworms want water.
2. Maybe the earthworms come out to breathe.
3. Maybe there is too much water in the ground so the earthworms will drown if they don't come out.
4. Maybe the earthworms' homes are ruined by rain and they have to come out.

SOLUTION:

A. Gathering data:

The teacher asked the children to suggest ways of finding out whether or not their answers were correct. As a result of the discussion, the children did these activities.

1. They put some earthworms on top of some soil and watched them burrow into the ground.
2. They examined some soil with a hand lens to see the spaces between the soil particles.

3. They put soil in water and saw bubbles of air escaping.
4. They poured water into a glass jar of soil until all of the air had bubbled out of the soil and water was standing on the soil.
5. They found earthworms in puddles where they had been unable to find drier soil.
6. They put water into the jar containing the earthworms and watched the earthworms.
7. The teacher drew an enlarged diagram of an earthworm's burrow to illustrate the relative sizes of worms to soil particles and air spaces.

B. Results:

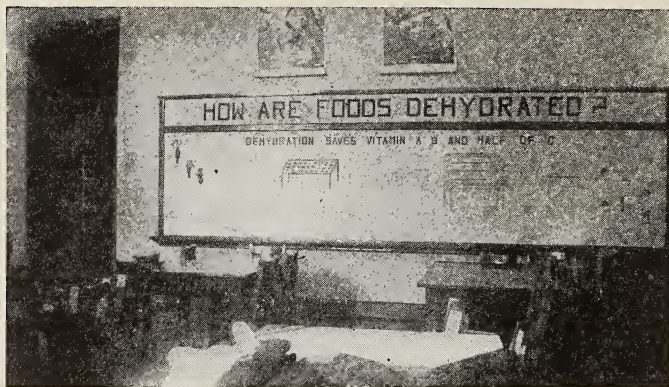
1. The earthworms burrowed into the moist soil, head end first.
2. The soil particles looked like tiny rocks.
3. & 4. Bubbles of air were plainly seen.
5. The earthworms in the puddles were dead.
6. As the water filled up the spaces between soil particles and air came out, the earthworms came to the surface and crawled out of the jar.

CONCLUSIONS:

When the earthworm's hole was full of water, it couldn't get air so it crawled out. When the ground was dry it would crawl back into its hole. If the earthworm couldn't get back into its hole and the ground was covered with water, it died.

This was a very simple problem but it offered all of the elements of real problem solving on a six-year-old level. The information could be gathered by the children themselves and was concrete enough for them to draw correct conclusions. They could check their results with those of the children in the story of earthworms in *THROUGH THE YEAR*.

This problem-solving lesson has illustrated the utilization by the teacher of a child's question for accomplishing her own objectives. We cannot always wait for questions to arise naturally to



As children grow older, their problems enlarge.

initiate science problems. The teacher must know the problems that are suitable for the group she is teaching, and at times she must create situations to motivate the setting up of these problems. Once initiated, the science program will usually keep going under its own power. New problems will grow out of those in the process of solution. The teacher and children will find themselves with more problems than they can possibly solve in the time they have. These problems should be recorded and used to start another year's work, or handled through individual or group reports.

As children grow older and develop more skill in handling problems, their problems will enlarge. They may break down these larger problems into minor problems to be solved. The time taken for solution will increase and the children may be taught to recognize the steps in their thinking. They may begin to record their data. This will be a group activity at first, with the teacher writing on the board the simple statements made by the children.

For example, a second grade in trying to answer their questions of "How did this piece of salt get on the shore of Salt Lake?" did some simple activities to clarify the concepts of *solution* and *evaporation*. At the end of one activity the teacher wrote the following results on the board as the children gave them to her.

1. Salt dissolves in water.

2. We couldn't see the salt in the water.
3. When the water evaporated we saw the salt again.

These children were able to check the results of this activity by reading in their second grade science text, *WINTER COMES AND GOES*.

Third-graders have developed enough reading skill to be able to supplement their own observations and experimentation by reading. They are also able to begin writing a few sentences as a record of the conclusions to their problems. The teacher should handle this just as she does the written language work the children do, being sure that the conclusions recorded are correct.

Analyzing problem solving for some of the difficulties that arise in teaching it, let us look at a rather simple lesson, "Why does a candle burn?" What are the concepts and skills a child needs for setting up the hypothesis and solving it? Some of the concepts needed are:

1. A candle is made of wax.
2. Wax is a solid.
3. Wax melts when heated.
4. Solids may be changed to liquids by heating.
5. Liquids may be changed to gases by further heating.
6. There is something in all fuels that burns.

Some of the skills the child will need are:

1. Ability to handle the simple apparatus needed.
2. Ability to observe accurately.
3. Ability to work carefully.
4. Ability to draw correct conclusions from accurately observed results.
5. Reading and language skills necessary for checking his results and recording them.

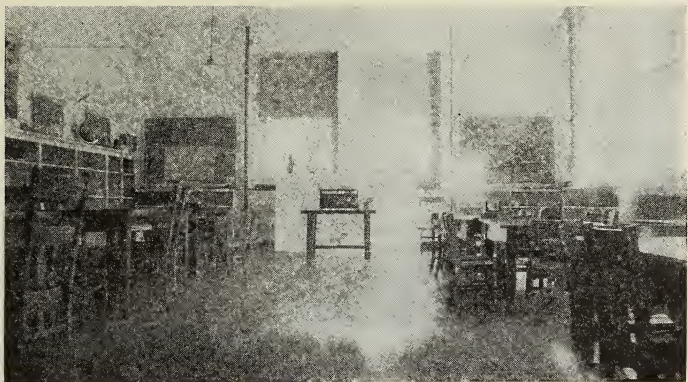
The teacher has to anticipate all of these needs and plan carefully. She must realize the safety measures to be provided in any experiment involving fire. She must guard against unscientific attitudes, such as drawing conclusions with insufficient evidence. She must be alert at every step in the procedure for opportunities to develop scientific attitudes and good habits of thinking.

Perhaps this all seems like a very complicated and difficult task to the teachers who have not used the problem-solving method. It would be if you started out trying to teach it all at once. If you begin slowly, one step at a time, you will find the children co-operating eagerly. The satisfaction gained by feeling that you are teaching habits of thinking that the children will be using long after they've forgotten some of the bits of information makes the effort worth while. A child's spontaneous comment at the end of the solution of the problem, "Why do teeth decay?" illustrates this point. It had taken some time to finish and the teacher was feeling a bit discouraged at the seeming waste of time. The child wrote his last sentence of the conclusion with an audible sigh of satisfaction and remarked, "Boy! I call that finishing a real job. That's really getting something when you find out yourself instead of just reading." When the children themselves realize the value of their learning, it must be worth while.

These values, in part, are:

1. The ability to recognize and formulate problems.
2. The ability to set up reasonable hypotheses.
3. The ability to gather data by means of suitable activities for testing the hypotheses.
4. The ability to record accurate results.
5. The ability to generalize from results, draw correct conclusions, and check with an authority.
6. The ability to apply the conclusions to similar problems.

In addition to these skills and habits, scientific attitudes and knowledge are gained in the solution of pertinent problems.

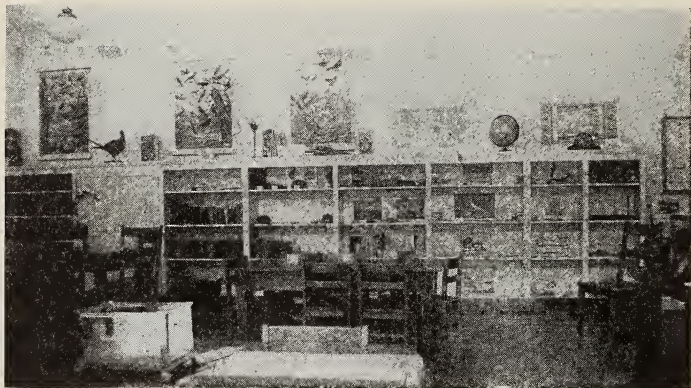


A science room.

SCIENCE ACTIVITIES COMMON TO ALL GRADES

THE SCIENCE ROOM

The problem of how to care for materials and specimens is a real one for the grade teacher. If there is a separate science room, these may be cared for in the cabinets, display cases, and closets provided for them. If not, some space must be allotted in the regular classroom. They need not take up much room, for the apparatus needed for teaching elementary science is simple. A few glass jars, dishes and bottles, a few tin cans, some pieces of wire netting, cheesecloth and some candles may be the only things needed. An electric plate, alcohol lamp, or some other source of heat is necessary for some of the experiments suggested. But if these are not available, other common experiences may be substituted. In some schools it is against the rules to have fire in the classroom. Unless an electric plate can be obtained, the radiator is the only source of heat. There is such a variety of home-made equipment and substitutes for expensive apparatus that the ingenious teacher can always find some material for her activities. Running water is a great convenience. The children should have



Shelves provide places for permanent collections.

a share in assembling needed apparatus but the teacher must be responsible for seeing that it is ready when it is needed.

The regular classroom may be made more attractive with a few well-kept aquaria, terraria, and growing plants. Suggestions for maintaining these in good condition are given in other parts of this Manual. A science table will provide for the specimens of rocks, insects, birds' nests, and other things the children collect and bring to school. It should be well kept and cleared at intervals. As a child brings in his contribution it can be discussed, named, and put on the table with a small sign telling what it is and the name of the donor. A few cases of shelves will provide a place for more permanent collections.

A table with a few interesting things that the teacher provides helps to stimulate science work. These specimens should have labels telling enough about them to arouse curiosity and a desire to know more. For example, an oyster shell may be labeled, "This is the outside of an animal. It lived in the sea. It is used for food. You have a relative of this *oyster* in your aquarium. Do you know what it is?" The relative is a snail or perhaps a clam.

In some schools, glass display cases in the hall offer a place where science material may be exhibited. These exhibits should be changed frequently. For example, a group of children may

be studying rocks. They may put some of their best specimens, with neat labels, in the hall case. Other children of the school will enjoy this display and learn from it.

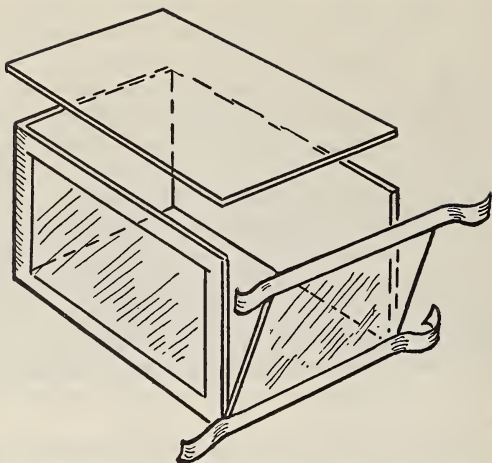
If the teacher wishes to buy equipment she may order it from any one of several scientific supply companies. Many of the things she needs such as dry cells, wire, and magnets may be bought at local ten-cent stores.

Bulletin boards are an important addition to the science room. They may be used by the children for the clippings and pictures they bring to class. The teacher may use them to motivate units or lessons, or to display summarizing activities at the end of a unit. They may be used for pictures of birds, wild flowers, or other aids to identification. There are many charts, such as the Audubon Bird Charts, which may be used for the same purpose. Bookshelves for reference books and magazines and a case for maps and charts should be provided.

Science material, whether it is alive, or is physical apparatus, must be kept in good condition. Nothing is so likely to kill the interest in science as dirty glassware standing around the room, cloudy aquariums, boxes of dead caterpillars, or unhealthy animals. There is much plain housekeeping in the science room, but all of it can be used to help teach children careful habits, particularly if the children are given the responsibility of helping to do this housekeeping.

HOW TO MAKE A TERRARIUM

A simple terrarium has so many uses that it is well to know how to make one. First, it is necessary to have a container. A glass jar of any kind will do, but one with straight sides is better than a round one. A glass box may be easily made from six pieces of window glass cut to the desired size. These may be fastened together with one-inch adhesive tape or black *passe partout* tape. Rub the tape until it sticks firmly to the glass. The lid may be fastened so that it is hinged, or merely laid across the top. All edges should be bound with tape to prevent cut fingers. A further precaution is to have the edges of the glass beveled at the time it is being cut.



A terrarium made from glass and adhesive tape.

A wooden base instead of a glass one may be used for the box. If wood is used, it should be so cut that at least one inch will project from around the glass at the bottom. The board may be treated with melted paraffin to make it resistant to water. A half-inch furrow should be sawed in the wooden base, the dimensions of the glass, and made wide enough to take the glass. The glass sides can be more firmly secured in the furrow by means of aquarium cement or putty. Adhesive tape may be put around the top to make smooth edges.

Having a container, start making the terrarium by putting a layer of gravel in the bottom, to provide drainage. Small pieces of charcoal will help keep it sweet. On top of the gravel put soil of the kind found where the plants grow which are to be used in the terrarium. For example, moss and ferns come from the woods. Use woods soil, or leaf mold, for a woods terrarium. Use garden loam for a garden terrarium. Use sand for a desert terrarium.

In the soil plant the moss, ferns, or other plants you wish to use. If you are going to put animals which eat plants into the terrarium, some of these food plants should be planted. For example, if



Making a terrarium for a garter snake.

making a home for grasshoppers, plant corn or oats and let it sprout before putting in the insects. For toads, use garden soil, a dish of water sunk into it, with perhaps some stones and a little grass. The toad will bury itself in the soil. Salamanders like moist moss and pieces of decaying wood under which to bury themselves. Lizards and horned toads will bury themselves in the sand of a desert terrarium.

The terrarium should be kept out of strong sunlight and in a place that is not too warm. It should be sprinkled with water when first made, if it has plants in it. After that it should be sprinkled only when the cover gets dry on the underside. Water should be kept in a dish if there are animals in the terrarium. Snakes go into water, and a tall container like a pint milk bottle or pickle jar of water will make them comfortable. A low dish is better for turtles and toads. This can be placed in one end of the

terrarium and stones and soil built up around it to the level of the top of the dish.

A single terrarium should not contain a large variety of animals. Since boxes of glass and adhesive tape are practical and inexpensive, it is better to have several, each one containing a different kind of animal.



A woods terrarium.

The food of frogs and toads in the wild state consists of insects, worms, caterpillars, snails, and slugs. They also eat flies, mosquitoes, and gnats. These can be easily provided, but they should always be alive. Frogs and toads will not touch dead worms or insects. They will starve in a terrarium if they have no live food to eat. A fly trap can be made and once a day the flies released from the trap into the terrarium. When there are insects out of doors, they may be caught by sweeping the grass with an insect net. In winter when flies are scarce, meal worms and meal bugs, which can be cultivated in bran flour, can be substituted.

Newts and salamanders can be fed on bits of raw meat, fish, oysters, scrambled eggs, worms, or insects. Land turtles are plant-eaters, using tender plants and berries for food. Water turtles are meat-eaters, using earthworms, insects, crayfish, and small fish. Mud turtles do not eat unless they are under water. Horned toads eat living insects. Garter snakes eat earthworms, insects, frogs,

salamanders, and toads. Snails are vegetarians; lettuce is a good food for them.

Care should be taken that an excess of uneaten food does not remain in a terrarium. Terrariums should be kept clean so that the captive animals may live in healthful conditions.

HOW TO MAKE AN AQUARIUM

Almost any container that holds water may be used for an aquarium, but a straight-sided one is best. The globe-shaped ones afford too little water surface for the absorption of air and they distort the shape of objects inside the aquarium.

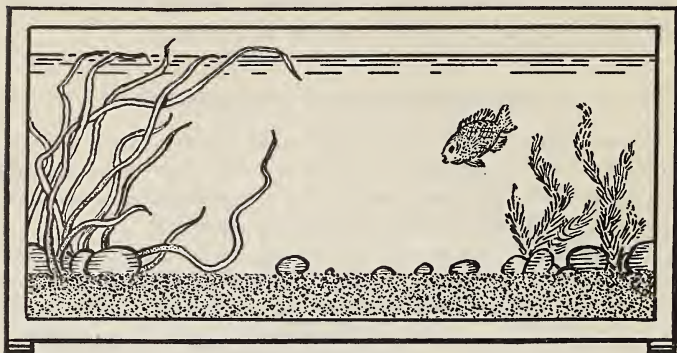
The container must be very clean, and the sand must be thoroughly washed. Sand may be washed by running a stream of water into the pan of sand until the water runs out clean. If the sand is then baked in an oven, any bacteria or mold spores will be killed.

Enough sand should be put into the bottom of the aquarium to insure a good root-hold for the plants. Elodea, eelgrass, and water milfoil are all good aquarium plants and are common in most of our fresh-water lakes and streams. These are satisfactory for summer aquariums but they do not always survive the winter. There are many inexpensive tropical water plants which can be used. Such varieties as *Valisneria*, *Cobomba*, *Myophilum*, and *Sagittarium* are commonly obtainable. It is believed that *Valisneria* is the best oxygenating plant. This is a grasslike plant which grows very quickly. Duckweed is a small leaflike plant that is often found floating on ponds. It is attractive in an aquarium, though it doesn't help to supply much oxygen.

The plants should be planted in the sand, then anchored with stones. Water can be poured into the aquarium without disturbing the plants by putting a piece of paper on the sand and pouring the water on the paper, or a dish may be placed on the sand into which the water can be poured.

Clean pond, lake, or rain water is best for an aquarium because it contains minute organisms that may later feed the animals. If tap water must be used, allow it to stand several days before putting it into the aquarium. This allows any lime that might spoil

the sides of the aquarium to be deposited and frees the water from any chlorine that has been added for purification. After adding the water, allow the plants time to become rooted before putting



A simple aquarium.

in the fish or tadpoles. Otherwise the animals may pull up the plants.

One rule for the number of fish in an aquarium is one three-inch fish to a gallon of water. Another rule is an inch of fish for each 20 square inches of water surface at the top. Most people are inclined to put more fish into an aquarium than the amount of water justifies.

Any kind of aquarium fish such as goldfish or tropical fish may be put into an aquarium. However, tropical fish are more difficult to keep than goldfish, and require more attention. The water temperature must be kept above 65° for tropicals, and the feeding must be more regular.

Of the tropical fish, guppies, swordtails, and paradise fish survive well and they have interesting habits. Guppies and swordtails are livebearers. Under favorable conditions, guppies reproduce every six weeks. The bubble-nests of the paradise fish are interesting. Tropical fish and goldfish should not be put together in an aquarium as tropical fish often kill the goldfish. Also the fighting paradise fish must be kept away from other tropical fish.

Some wild fish will survive in an aquarium and they make in-

teresting pets. Small sunfish, bluegills, and bullheads are examples.

Snails should be put into the aquarium to act as scavengers. They help keep the sides of the aquarium clean. Tadpoles will serve the same purpose. Clams also help keep the water clean. If water turtles and small frogs are put into an aquarium, they should be provided with flat pieces of wood onto which they can crawl and get out of the water for air.

The first rule in the feeding of fish is not to overfeed. Only a small amount of food should be given, or as much as will be consumed at that feeding. Food not eaten at once falls to the bottom of the container, sours, and makes the water impure. Goldfish can be fed as seldom as once a week. They should not be fed more than three times a week. Tropical fish should be fed three times weekly.

Oatmeal (cooked), boiled white of egg, cream of wheat (cooked), liver (cooked), beef (cooked or raw), chopped earthworms, and flies are good food for both goldfish and tropicals. These foods are better than artificial food. If wild fish are used, the children should find out about the natural food of these fish and supply it as nearly as possible. Wild fish can usually be fed on earthworms and chopped raw beef. They will also eat live insects placed on the surface of the water.

If the aquarium is balanced, the animals and plants will look healthy and the water will be clear. Cloudy or milky water is probably due to the spoiling of uneaten food, or to decaying plants. This water is bad for fish. Immediately remove the fish and clean the aquarium and replenish with fresh water. In changing fish from one container to another, keep water temperatures the same. Fish cannot stand sudden changes of temperature. Be sure also that tap water has been properly conditioned to remove chlorine.

Fish should be handled with a small net or lifted out in a dish of water. Grasping them with the hands is likely to break the film over the scales and permit fungus to get started. If a fish is diseased, remove it at once and put it into a solution of salt water, in proportions of one teaspoon of salt to a quart of water. It may remain in the solution for a period of several hours. Then put it

into a container of fresh water. Repeat the treatment every day until the fish is well.

The children will get much pleasure and profit from their management of both terraria and aquaria. There are many interesting aquarium books and magazines on the market to which they can turn for lists of animals and plants and for notes on feeding. Also in recent years there has been much interest in amateur tropical fish raising and many of the children may come from homes where there is a tropical fish enthusiast.

HOW TO CARE FOR CATERPILLARS

Some caterpillars spin cocoons, some form chrysalids, some go into the ground to pupate, some spend the winter hibernating in the larval stage. In discussing them with the children, suggest that since the caterpillars they find may not be ready to pupate, they must be sure to bring in some of the leaves on which they find the larvae. Then you will know what to feed them. Caterpillars will leave food and hunt a suitable place when they are ready to pupate. Polyphemus caterpillars may be put into a glass jar that has some twigs with leaves on them. A piece of glass may be laid over the top of the jar. This prevents escape of the caterpillar and also helps keep the leaves fresh. If the caterpillar is still hungry it will eat the leaves. The jar should be cleaned each day and fresh leaves put into it. When the caterpillar is ready to spin, it will use the twigs and sides of the jar as its foundation and spin leaves into its cocoon. When the cocoon is finished, it may be removed from the jar and put into a cool place until spring. Jar and all may be put away. If it is kept in a dry place, the cocoon should be dipped in water once in a while.

Caterpillars like the tomato sphinx (tomato worm) go into the ground to pupate. There should be some garden soil in the bottom of the jar for them. A flower pot with a cylinder of wire screening over it is good, also. Some Woolly Bears hibernate in the larval stage so a terrarium with some dead leaves and pieces of bark makes a good home for them. They will spin in the spring. Some Woolly Bears spin in the autumn.

The Monarch or milkweed caterpillar forms a chrysalis. If the children bring any Monarch caterpillars in, put them into a jar

with milkweed leaves. When ready to pupate, they will spin pads of silk on the underside of a jar lid, leaf, or twig, then hang from it and shed the larva skin, leaving the green chrysalis. Since the caterpillars that form chrysalids in the autumn soon emerge, they may be left in the room for the children to watch. Chrysalids of butterflies that emerge in the spring may be cared for in the same way as the cocoons.

Fruit and salad dressing jars are just as good as more elaborate equipment. The main things to keep in mind are to have fresh leaves of the right kind which are kept from drying too quickly but are not wet, and not to have too much heat. After pupae are formed, they should be placed in a cool place, not moist enough to mold, but not dry enough to kill the pupae. Cleanliness in their care is important, as many caterpillars are susceptible to disease. Also when handling caterpillars, be careful not to bruise them. It is better to let them crawl onto a twig and then move the twig, than to pick them up with your hands.

OTHER ANIMALS IN THE SCIENCE ROOM

The extent to which it may be desirable to keep animals in a schoolroom depends upon the size and facilities of the room, the interests of the children, and the kinds of animals you wish to keep. While some plants and animals if properly cared for are sure to make a room more interesting, we mustn't lose sight of the fact that the children are the most important occupants of the room. If having other animals makes the room less attractive or comfortable for the children, you should either do without the other animals, or choose animals that are easily kept in captivity and cared for.

Directions for the care of aquarium and terrarium animals have already been given. All these cold-blooded animals are clean in their habits and have little or no odor about them.

Small mammals such as rats, mice, guinea pigs, and rabbits may be kept in cages in the room if the cages are kept clean. Cages with removable metal bottoms are more easily cleaned than wooden ones. A cage may be made of an orange crate with a galvanized iron tray made to slide in the bottom of the box. One-



Observing a turtle.

half-inch mesh galvanized wire should be fastened to the open side and a sheltered corner should be made of a smaller box which is placed inside the cage. All animals need to have a place in which to hide.

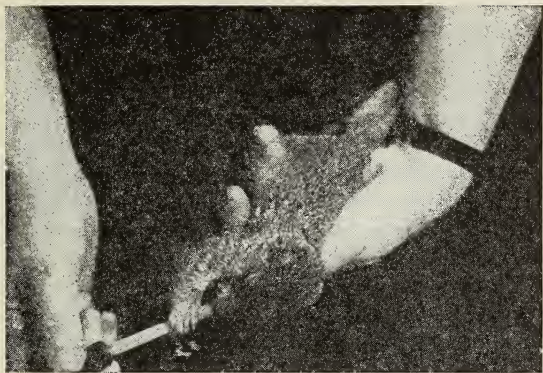
Sawdust or straw should cover the floor of the cage and be replaced with fresh material every day. If a layer of newspaper is put on the floor first, the cage can be more easily cleaned. The animal will carry some of the nesting material into its sheltered corner for a bed.

Guinea pigs and white rats are more easily kept in a schoolroom than rabbits. Rabbits may be brought in for a day or two, but it is better for them to live out of doors.

These rodents may be fed oats, alfalfa hay, carrots, and other vegetables. The young ones should have milk and a few drops of cod liver oil each day during the time when they do not get plenty of sunshine.

If the schoolroom is closed and becomes either very hot or cold over the week-ends, the animals should be taken to the home of one of the children. Extremes of temperature are not good for warm-blooded animals, particularly when in captivity where they can't protect themselves.

Although many of these animals are able to get their water from



Feeding a young squirrel.

their food, water should always be provided in the cages. The container should be low enough for the animal to drink from and of a kind not easily tipped over.

Wild rodents, such as meadow mice, squirrels, and chipmunks are sometimes brought into the schoolroom. Adult wild animals are difficult to tame and often refuse to eat. Young wild rodents, however, may be cared for and make interesting pets. If they are very young they may be fed on warm, diluted condensed milk. The smaller the animal the more warm water should be added to the milk, the more frequently it should be fed, and the less it should have at each feeding. One needs to use common sense in caring for these young animals. Keep them warm, let them alone as much as possible, and don't overfeed them.

Children sometimes bring other young mammals to school. Until the animal is old enough to eat solid food, its care is the same as for the other animals mentioned above. Teachers may find detailed directions for rearing all kinds of wild animals in Moore's *Wild Pets*. See reference list.

Young birds are easily reared if you know the food to give them. Any good bird book will tell the food of the common species of birds. Insect-eating birds may be fed earthworms, caterpillars, and small larvae of beetles. Hard-boiled eggs may be substituted

for part of their food. The shells should be crushed and fed with the egg. Young flickers may be fed on raw eggs and ants.

Seed-eating birds may be fed any kind of small seeds. Chick-feed is easily obtained. Some bread may be given them but should be supplemented with seeds. All birds need sand and other hard foods.

When a bird is first found it may have to be fed forcibly. Open its beak gently and put the food in the back of its throat. A pair of forceps or tweezers is useful in accomplishing this. The bird won't swallow unless the food touches the swallowing center on the back of its tongue.

Fish-eating birds such as bitterns and loons are occasionally found and brought to school. These are problems to feed as they do not thrive on dead fish. The author has successfully fed young fish-eating birds on live tadpoles and minnows.

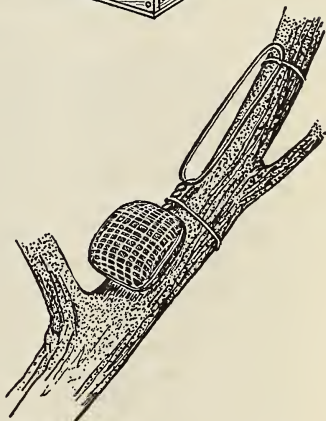
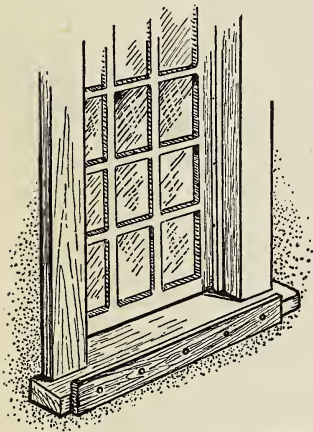
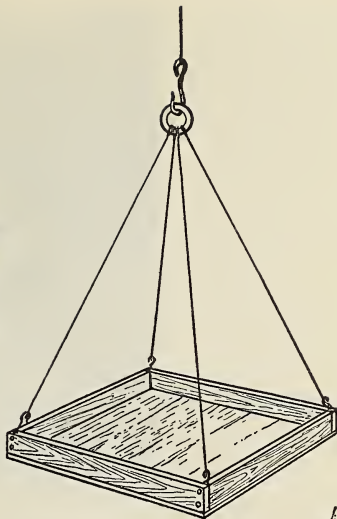
Hawks and owls may be fed pieces of meat which have been wrapped in cotton or rolled in sand. These birds should be handled with care as their bite is painful. Young ones soon learn where their food is coming from and open their mouths.

Unless a wild animal is too young to care for itself, it is wise to keep it awhile for study and then release it. School buildings are not built to house the lower animals. A trip to a well-run zoo will demonstrate how varied are the needs of the different groups of animals. It would be impossible to duplicate these conditions in a room where children live. A cage built outside a window on a level with the window sill will partially solve the problem. If a squirrel or rabbit is to be kept for any length of time this might be worth while.

In caring for any animal, the children should be made to feel responsible. They should read about the natural habitat and food of the animal and try as nearly as possible to duplicate these conditions. Even though some animals die, the value to the children makes caring for them worth while.

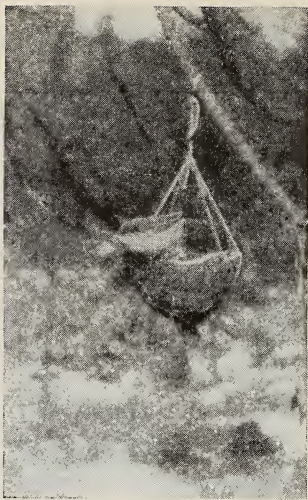
WINTER BIRD FEEDING

In the northern part of the United States most of the common birds migrate in the autumn but there are a few that remain through the winter. Why birds migrate is a question no one has



Simple feeding stations for birds.

solved satisfactorily, although there has been much written on the subject. The teacher should familiarize herself with the theories of migration and not try to solve the problem.



*Half a coconut may be filled
with melted fat.*

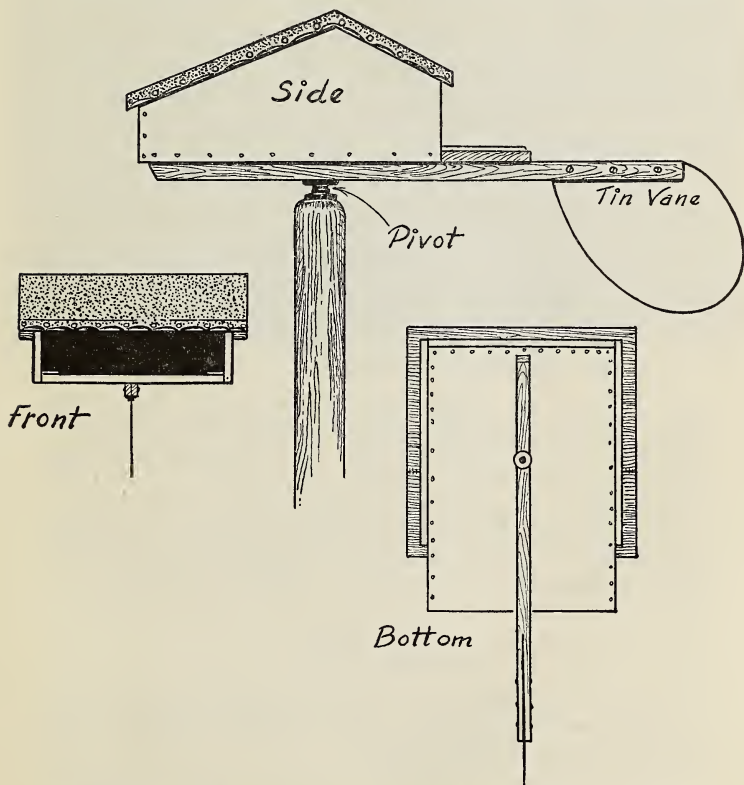
Some winter bird residents stay the year around in the north. Among these are the chickadees, nuthatches, and downy woodpeckers. Others come from farther north, spend the winter, and return to their northern nesting grounds in the spring. Brown creepers, juncoes, and tree sparrows are examples of these.

Some winter birds are insect-eaters and some feed on seeds or fruit. The downy woodpecker is able to chisel through the bark of a tree and with its tongue spear the larvae underneath. Nuthatches and brown creepers get insect eggs and insects from the crevices in the bark. Chickadees and titmice find their insect food mostly in the buds and on the twigs of shrubs or trees. But in winter, all of these will eat whatever they can find. Since they are meat-eaters, we put suet or nuts on the feeding shelf for them. To prevent suet from being carried away by a blue jay or starling, it may be put into a wire basket made of coarse screening.

A soap shaker may be filled with suet and hung from a wire. The suet may be tacked to a tree or tied to a limb. The nuts

should be crushed or finely cracked to prevent squirrels from carrying them away. Birds will scratch among the shells and pick up the bits of nut meats. Walnuts or hickory nuts are good bird food, and may be gathered by the children in the autumn, to save for winter feeding. Half a coconut may be filled with melted fat and hung from a branch. Cracked nuts or seeds may be added to the fat.

Juncoes, sparrows, goldfinches, and cardinals are seed-eaters.



A more elaborate feeding station.

Any seeds, such as wheat, oats, millet, or cracked corn, will attract them. Sweepings from a mill are welcomed by birds and they will scratch in the chaff for days, finding tidbits. Cardinals and grosbeaks are especially fond of sunflower seeds. Crumbs of any kind will attract birds, as will berries and pieces of other fruits. The children can put out discarded apple cores and cranberries. Breakfast food or other cereals which might be discarded because of weevils are good bird food. Even weed seeds are attractive to birds.

Shrubs with berries on them always attract birds. Among these are snowberry, barberry, high-bush cranberry, wild plum or cherry, and bush honeysuckle. Teachers who have anything to do with landscaping the school grounds should see that some such shrubs are planted.

A simple shelf is as effective as a more elaborate one. Just an extension from the window will work, although a roof prevents snow from covering the food. The birds may not come at first, so a good way to get them started is to sprinkle some grain on the ground under the shelf. The sparrows will come first and though we do not care so much for them, they show the other birds the way. A dry doughnut dangling at the end of a string will provide entertainment equal to circus acrobats.

A swinging shelf usually frightens sparrows and drives them away. However, for teaching purposes in the primary grades even an English sparrow has possibilities. It is surprising how many adults do not really know English sparrows.

In snowy, freezing weather, water is as hard for birds to get as is food, so water should be put out for them each day. It will often attract birds not attracted by food. A shallow earthenware container like the saucer of a flower pot is good for this purpose.

FIELD TRIPS

If properly conducted, a field trip may be an important activity to help in the solving of some science problem. Improperly conducted, it may be a waste of time.

A field trip must have purpose. It must come as a result of a need to learn something outside the schoolroom. It need not mean



A field trip—looking for birds' nests.

a long trip. For example, in a discussion of soil formation the question may arise of whether freezing and thawing break up rock and form soil. To illustrate this, the children may go outdoors and find rocks that have been cracked in this way. Even sidewalks and the foundations of buildings illustrate the point.

The teacher should anticipate any trip she plans and make the trip herself before she takes the children. If she intends taking the children to see birds, she should make sure that there will be birds to see. Birds are elusive and cannot be tagged and made to stay in one place. But a nest that is being built, or the work of a woodpecker located by the teacher or some member of the class, will remain until the whole class sees it. With a definite objective in mind, the teacher is sure to prevent disappointment and aimless looking.

Before starting on a trip, the teacher must be sure that every



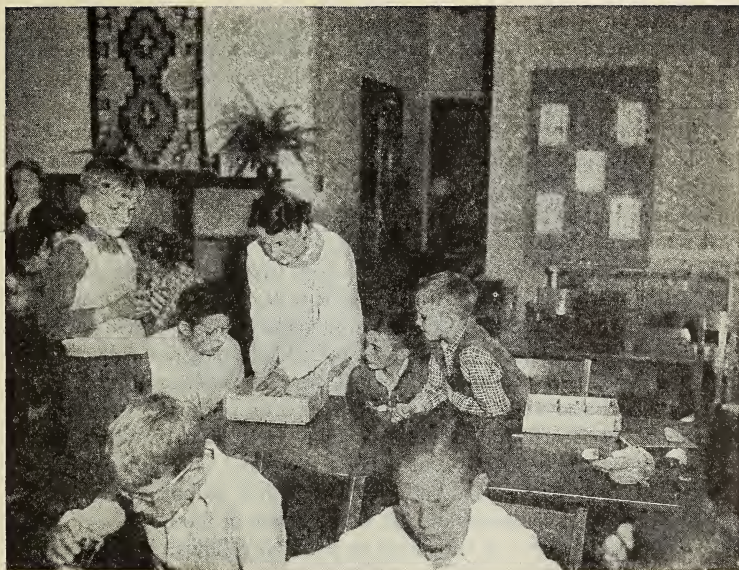
A field trip—locating territories of birds.

child knows what he is going to look for. There is endless variety in the number of interesting things to see out of doors, but unless the attention is directed to a few, there will be confusion, and no learning will result.

For example, on the way to a river to see erosion, the group may watch for terraces that have been made as the river cut down to its present bed.

A large group should be organized into small units with a leader for each. These may be working on the same problem or different problems. If unusual things are found, the whole group may be called together to see them.

A simple way to organize groups is to make enough slips of paper for each member of the class. Number them from one to five. Circle one one, one two, one three, one four, and one five.



After a field trip—rock study.

Have the children draw slips. All the ones make a group. All the twos make a group, and so on. The children with the circled numbers are the leaders for the day.

Children like to make their own rules for field trips and take pride in following them. Here is a set of rules made by a third-grade class before going on a trip to study birds.

1. Walk quietly. No loud talking.
2. Follow your leader.
3. When you see a bird, stop. When the leader stops, everyone stops.
4. When you see a bird and want to show it to the rest of the group, tell them where it is without pointing. (Birds see better than they hear and are startled by quick motions.)
5. When you are looking at a bird, stand with your back to the sun.

Too many rules are confusing just as too many directions are. It is better to take short trips at first, trying out one rule; then add more rules as longer trips are taken. If the children understand what the trips are for, they will gain the proper attitudes toward them.

It is very important in any science work to respect the discoveries and ideas of children. When they see or find things on a trip, the group should give as serious attention to them as to the teacher's contributions. This encourages children to observe and it intensifies their interest.

On a collecting trip, enough containers should be taken along to carry back any specimens. Directions on how to collect and what to collect should be clearly understood before leaving the school. Collecting should be done only when material collected is to be used. If such material may be studied to better advantage in the schoolroom than out of doors, it serves a purpose. But only as much as is needed should be taken. Gathering hundreds of frogs' eggs would be wasteful when a few would be all the children could care for. It is better to raise a few tadpoles to adulthood than to have dozens die for lack of room or food.

Some of the types of trips may be listed as follows:

1. A trip to locate territories of birds. Return at regular intervals to watch nest building and rearing of young.
2. A trip to collect rocks.
3. A trip to see types of erosion.
4. A trip to find tracks of animals.
5. A trip to find and collect galls.
6. A trip to a zoo or museum to see something that has been discussed in class, such as fossils.
7. A trip to a meadow to collect weed seeds.
8. A trip to observe the sky.

The suggestions for teachers in connection with the stories list other ways to give purpose and variety to field trips. Trips should never grow so common or become so regular as to be monotonous, nor so dull as to be meaningless. Children should always regard them with enthusiasm, not because they offer an opportunity for play, but because they are the most satisfying solution to many of their science problems.



THE HOW AND WHY SCIENCE BOOKS

BASIS FOR CHOICE OF MATERIAL

CHILDREN'S INTERESTS

Children's interests were closely studied in preparing and organizing the material used in *THE HOW AND WHY SCIENCE BOOKS*. The subject matter was used by the authors in actual teaching experiences over a period of several years and with many different age groups of children. The problems were used in mimeographed form until arranged for publication.

RECENT COURSES OF STUDY

The material for the books was originally chosen from units that appeared in many courses of study from many sections of the United States. City and state courses of study were consulted, as well as those prepared and used in teacher-training institutions. More recent studies, problems which have arisen in the classes of the authors, and new courses of study have added new material to the original series.

The outlines for science in the elementary grades found in the *Thirty-First Yearbook* and in the *Forty-Sixth Yearbook* of the National Society for the Study of Education have been closely followed. Some quotations from the *Forty-Sixth Yearbook* are of interest here:

"Instruction in science should begin as early as children enter school; activities involving science should be provided even in the pre-school and the kindergarten. Through the sixth grade the work in elementary science should consist of a continuous integrated program of the sort advocated by the *Thirty-First Yearbook*. Such a program should provide an expanding, spiral development of understandings, attitudes, and skills, as prescribed in chapter iii."—pp. 41-42

"It is most important that the material selected for each grade of the primary school be balanced to include the elements of learning which represent a rich experience with science. Each level should give the child some opportunity for exploration with content derived from the great major fields of science: astronomy, biology, geology, and physics. This cannot be accomplished by studying only plants and animals.

"There should also be balanced instruction as to the types of activities employed. Children should have a rich opportunity to develop their abilities in discussion, in experimentation, in observing in the out of doors, and in reading for information and motivation. A complete program of instruction in primary science can be maintained only by the full utilization of all these activities, for each plays its part in the development of the purposes of science education."—p. 84

"Since experimentation involves 'learning by doing,' there can be no substitute for it. Pupil experimentation is an essential part of science education. In every course of science offered at any level, therefore, opportunities should be provided for pupils to perform experiments."—p. 53

"The basic purpose of the elementary school is the development of desirable social behavior. Science, with its dynamic aspects, its insistence upon critical-mindedness and better understanding of the world, and its demand for intelligent planning, has a large contribution to make to the content and method of elementary education.

"To accomplish this basic purpose a continuous program of science instruction should be developed throughout public school education, based upon a recognition of the large ideas and basic principles of science and the elements of the scientific method. Children must be given opportunity to gain the knowledge necessary for intelligent and

cooperative experience with the world of matter, energy, and living things and to develop constructive appreciations, attitudes, and interests. This demands that the individuals in our society become intelligent with reference to the place of science in individual and social life.

"When the content and method of science are examined, it is found that the child's normal activities have much in common with the purposes of science in modern society and that the teacher can view the teaching of science as utilizing the natural dynamic drives and potentialities of children."—p. 73

"Work in the primary grades should not be exhaustive. Rather the child should feel that there is more to learn about everything that he does. A developmental point of view demands that a well-balanced program provide contacts with realities. It cannot allow omissions in the development of the concepts, principles, attitudes, appreciations, and interests derived from the field of science."—p. 82

"The new program of science, which emphasizes the development of desirable social behavior, is organized around problems that have social value and are challenging and worth while to children. The teacher must, therefore, look back of the objects of the universe to the problems which involve meanings that the children will need to understand in order to participate intelligently in life. This means that, in science, opportunities must be provided for the development of understandings in all the areas of the environment and at all levels of social needs."—p. 92

HEALTH, SAFETY, CONSERVATION, AND AERONAUTICS AS INTEGRAL PARTS OF A SCIENCE PROGRAM

The authors of THE HOW AND WHY SCIENCE SERIES have made health, safety, conservation, and aeronautics integral parts of the science program. This is in accordance with the recommendations of the *Forty-Sixth Yearbook*:

"What is the place in the science curriculum of conservation, aeronautics, physiology, and health education? The materials of these areas are of value chiefly for general education. Except, perhaps, for an eighth-grade one-semester course in health and physiology, it is probably not desirable to offer separate courses in any of these subjects. Their materials can be more effectively integrated with those of the regular courses of the science sequence and with other courses in the program of studies."—p. 46

"The content of the science program in many elementary schools is now being organized around problems which have social value and which are significant in the lives of children. These problems arise from children's

interest in the world around them and from their need to meet intelligently their problems of living in areas such as health, conservation, and safety. They are solved not through the mere accumulation of facts but in such a way as to help children (1) develop meanings which are essential to social understanding, and (2) put into practice desirable social behavior. Problems involve meanings in their solution, and meanings are learned through experiences.”—pp. 69-70

“A program in science should develop a large background for the teaching of health. Many schools are now integrating health entirely with science and the social studies. Science provides much of the background for the teaching of health facts and the development of health habits. Moreover, in their study of science, pupils should gain a vision of the potentialities of science in the improvement of the health of the nation and the world.”—p. 76

“Likewise, science is involved in accident prevention and safety instruction. We cannot fully anticipate the environment of the future. New inventions may eliminate present hazards and create new ones, making it impossible to develop a code of conduct in safety instruction which will be functional for an entire life span. It may be well, then, in safety instruction to place more emphasis upon the scientific principles which are basic to safe conduct.”—p. 77

“The place of science in bringing about the wise utilization of natural resources to the welfare of mankind is an important aspect of the science areas related to the social needs.”—p. 77

Health lessons throughout THE HOW AND WHY SCIENCE BOOKS are not labeled as such but take their places naturally as a part of the science program. They are taught also by implication in the illustrations. If health concepts are included in a science book, children learn to assume a scientific attitude concerning health problems. Many science problems are also health problems. The use of the thermometer is taught in science, and it has many implications for health. The germ theories of disease, contagion, and quarantine are all science subjects that are important in health.

Safety is taught both in connection with health and as a part of scientific procedure.

Many activities in science may contribute to the goal of conservation education. Appreciation of the natural and physical world (one of the objectives of all science teaching) should lead

to conservation of wild life and other natural resources. Throughout the books of THE HOW AND WHY SCIENCE SERIES are such stories as "We Need Soil," "Insect Catchers," "Plants Depend on Animals," "Animals Depend on Plants," "Use—Don't Waste." As in the case of the health and safety lessons, the conservation material takes its place naturally as a part of the science program.

Although World War II gave an added importance to the subject of aeronautics, and a considerable number of separate courses in this field are being taught, chiefly in the senior high school, the authors of THE HOW AND WHY SCIENCE SERIES believe that this subject can be more effectively integrated with the regular science course. Beginning in the Pre-Primer, the books of the series provide valuable and adequate instruction about the science of flight. Again, this material takes its place as a part of the science program in the study of air and its properties.

THE PLAN OF THE PRIMARY SERIES

SCIENCE THROUGH STORIES AND PICTURES

The books of THE HOW AND WHY SCIENCE SERIES have a wide scope, including the fields of natural science, physical science, and human science.

The plan of the primary books is to tell stories dealing with the interpretation of natural phenomena common to the experience of children. Science is just as exciting as any other body of subject matter if told in a way that appeals to children. However, the restricted vocabulary of the early grades is often a handicap in presenting what are really simple science concepts. Such concepts can be taught effectively by pictures. In fact, before children can read the words, they enjoy looking at the pictures, and may learn science concepts from them. The books of THE HOW AND WHY SCIENCE SERIES are beautifully and effectively illustrated. The pictures are reproduced from original water-color paintings by a method so faithful in its reproduction that the illustrations in the books seem themselves to be original paintings.

Nowhere is there a better expression of what appeals to children in the way of books than in the opening chapter of *Alice in Wonderland*:

"Alice was beginning to get very tired of sitting by her sister on the bank, and of having nothing to do. Once or twice she had peeped into the book her sister was reading, but it had no pictures or conversation in it, and 'What is the use of a book,' thought Alice, 'without pictures or conversation?'"

The books of THE HOW AND WHY SCIENCE SERIES have *pictures* and *conversation*. The pictures are accurate and beautiful. The conversation is natural and interesting.

THE ORGANIZATION OF MATERIAL

The early books of the series are organized seasonally although the units may be taught at any time. Biological units to be natural have to be seasonal.

Most scientific principles are too difficult for little children to understand. But they can understand concepts which may grow from year to year until finally they can be put together to make a principle. For example, the principle that living things have certain modifications of structure which make it possible for them to survive is too difficult for first-graders. But they can observe that animals are doing different things in autumn, winter, and spring. In the second grade they learn more about these animals such as ways in which they survive the winter by hibernating, pupating, and migrating. In the third grade they enlarge the idea to include ways these animals are protected so that they do survive, such as fur, scales, and feathers. Thus as children are able to comprehend larger concepts, they gain them. Eventually they will be able to derive the principle that animals have survived through the ages because of modifications in their bodies that make it possible for them to live in the environments in which they find themselves.

Because the authors believe in the problem-solving method of teaching, the material in the outlines is organized in the form of problems. If the teacher keeps these problems in mind as she teaches, purpose will be given to her work.

ILLUSTRATIVE MATERIAL

Environment and individual differences play such an important part in children's science interests that the teacher must be guided by her own group in the choice of problems. Some problems may have to be teacher-motivated because lack of experience on the

part of her group may mean that the children will not initiate them. Once introduced to the material, children should accept it with interest, otherwise it is not suitable for them.

The teacher who has had little science experience will find help in knowing what may interest her group from the suggestions given in this and other Manuals for the series, but *she should always be ready to follow child-initiated activities when they arise*. She should not be like the teacher who, having planned a lesson on buds, was disturbed when Johnny brought in a turtle. "Take it right back," she said. "Today we are studying buds."

Illustrative material should come primarily from the child's own environment, but not exclusively so. In this regard the *Thirty-First Yearbook*, page 148, states:

"Some have contended that no illustrative material should be used except that which is in the natural environment of the school. This seems to be a very narrow interpretation of illustrative material. In this day when the child listens to the events happening in Antarctica, or other far parts of the earth, in which his environment is spreading out so that the whole world comes into his own home in one way or another, to restrict the illustrative material to local, indigenous objects seems, indeed, to be inexcusable."

The subject matter of THE HOW AND WHY SCIENCE SERIES has been arranged to appeal to as many different groups as possible. Biological units have been chosen in such a way that different sections of the United States are represented. Illustrative material is taken from the East, the West, the Middle States, and the South, thus broadening the scientific concepts acquired by the children using these books.

VOCABULARY TREATMENT

Background of experience and facility in the use of oral expression are prerequisites to the understanding of printed material but are not the sole factors involved in reading that material. Word pronunciation and mastery are factors of equal importance.

To this end, the authors of the primary books of THE HOW AND WHY SCIENCE SERIES have constantly kept in mind the problems of vocabulary mastery. Each new word has been checked against the Stone and the Gates standardized lists of vocabulary for the primary grades to determine the level at which the word should

be used. Adequate and consistent growth in expansion of the child's vocabulary, level by level, has been carefully and scientifically planned.

Each sentence in the books has been analyzed with readability in mind. Length of sentence, sentence structure, difficult words, as well as the nature of the concepts involved have been used as criteria for checking readability.

Such minor points as the one dealing with variations have been taken into consideration in writing the text. For example, if the words "help," "helping," and "helpful" were to be used, the base form "help" appeared first when possible. The variations "helping" or "helpful" appeared later. The singular form of a word appears before the plural form when possible. No compound words, contractions, or variants, except those made by adding "s" were used at the first reading level. The introduction and use of such words were carefully planned at each level throughout the series.

As a teaching aid, a list of new words for each book is given in the back of that book, with an explanation of the writers' plan in the introduction, repetition, and use of these words.

Using the latest research on the problem as a guide, the mechanical aspects of the reading have been as carefully worked out in this series as in any basic reading program.

THE COMPANION BOOKS

There is a Companion Book designed to accompany each of the texts. The objectives of each of the primary Companion Books are to:

1. Extend and enrich certain concepts
2. Develop a scientific way of thinking
3. Promote language growth

To arrive at these objectives the following activities have been planned: coloring (governed by knowledge of concept), cutting, pasting, and freehand drawing; matching of ideas; selecting and evaluating ideas; placing ideas in proper sequence; reading statements and matching them with pictures; reading simple problems and solving them; doing simple experiments and recording data by

pictures or other means on their level; doing simple tests of concepts learned.

Most of the activities in the primary Companion Books are ones that primary children can do alone. However, there are a few that will require a little thought on the part of the teacher, and at least some discussion. The authors are convinced that as the children acquire more skills, new learning should take place—that the Companion Books should not be just testing programs but an application of principles and concepts to new situations; that the lessons should require the using of skills which are necessary in gathering scientific data and solving problems to attack problems similar to those the children have read about in the text. The authors are determined that these books shall not be the busy-work type—all coloring, cutting, and pasting. All the work in the Companion Books, if used as designed, should serve as an aid in determining the accuracy of the concepts.

AN OUTLINE SHOWING THE DEVELOPMENT OF CONCEPTS

Although each Teacher's Manual contains a detailed outline for a year's work, it may be helpful here to show in chart form the plan and organization of the entire primary group of the *How AND WHY SCIENCE SERIES*.

In an effort to accomplish this purpose, the chart on the next two pages is presented. It is a master chart to show the organization of all five books. An examination of this chart will show that the entire field of elementary science is divided into three main content areas—those of Living Things, Physical Environment, and Health. The horizontal divisions show how the concepts grow from book to book and contribute to principles in the upper grades. Vertically, each column represents in brief the science program presented in a single book.

A large, more detailed chart is published separately. In this separate chart the horizontal development shows in more detail the growth of the concepts, and the vertical columns present more elaborate outlines of the material covered in each book. This separate chart may be secured upon request.

ORGANIZATION OF THE ELEMENTARY SCIENCE PROGRAM IN THE HOW

<i>Content Areas</i>	<i>We See—Pre-primer</i>	<i>Sunshine and Rain—Primer</i>
LIVING THINGS ANIMALS <i>(See also detailed chart published separately)</i> In <i>WE SEE</i> these concepts are developed by means of pictures.	There are different kinds of animals. Animals are alive. Some animals will need to be fed in winter. Squirrels, ducks, and turtles all have young. Animals eat many kinds of food. Animals go through changes as they grow.	Animals are affected by the seasons. 1. Animal activities in autumn. 2. Animal activities in winter. 3. People get ready for winter. Animals live in different places, differ in structure, and eat different kinds of food. Animals make tracks in snow or mud by which we can follow them.
PLANTS <i>(See also detailed chart published separately)</i>	Plants are alive. Seeds grow when planted. Plants have life cycles. Plants are affected by the seasons—autumn, winter, spring, and summer.	There are different kinds of plants. Plants grow in different places. Plants are affected by the seasons. 1. Trees in autumn. 2. Trees in winter. 3. Trees in spring. 4. Trees in summer.
THE BALANCE OF NATURE <i>(See also detailed chart published separately)</i>		Children can make simple homes for animals.
PHYSICAL ENVIRONMENT WEATHER AND SEASONS <i>(See also detailed chart published separately)</i>	The earth is made up of land, water, and air. We have day and night. There are different kinds of days. We have four seasons. The change of seasons affects animals, plants, weather, and length of day and night. Air is all around us. We see rainbows in the sky. We see rainbow colors in water.	The land, water, and air are farther away than we can see. We travel on land and water and in the air. Rain, fog, and snow are water. Water has different forms. Length of day and night changes.
THE SKY <i>(See also detailed chart published separately)</i>	The sun shines on the earth and makes day. We can see the moon and stars in the sky at night. We are in the earth's shadow at night.	Light from the sun makes us warm. Light from the moon and stars helps you see at night. Sunlight helps things grow.
EARTH STUDY <i>(See also detailed chart published separately)</i>	The earth is large. The earth is land, water, and air. Seeds are planted in soil. Air is all around us.	The earth is very, very large. People, other animals, and plants live on the earth. We can travel over the earth.
FORMS OF ENERGY <i>(See also detailed chart published separately)</i>	We use electricity in our homes. A magnet pulls some things.	The sun gives us heat.
SOUND <i>(See also detailed chart published separately)</i>		
BUOYANCY <i>(See also detailed chart published separately)</i>	Boats float on water.	Boats float on water. Kites float in the air.
MACHINES <i>(See also detailed chart published separately)</i>	We use machines in our home. Machines make work easier.	A windmill is a machine. Windmills do work.
HEALTH GROWTH CLOTHING BODY—PARTS AND FUNCTIONS CLEANLINESS FOOD POSTURE EXERCISE AND PLAY SLEEP AND REST COMMUNICABLE DISEASES SAFETY REPRODUCTION OF LIFE	Plants and animals need food and air to grow. Wear seasonal clothing. Keep your body clean. Eat the right food. Play out of doors. Cross streets carefully. Do not play in the street. Animals and plants make others like themselves.	All living things need food and air to grow. Seasonal clothing. Ready for school. Good foods. Ways of storing food for winter. Seasonal play. Colds are communicable. Children with colds should stay at home. Going to school. Butterflies reproduce. Bulbs make new plants.

AND WHY SCIENCE SERIES, PRE-PRIMER THROUGH THIRD GRADE

<i>Through the Year—Book I</i>	<i>Winter Comes and Goes—Book II</i>	<i>The Seasons Pass—Book III</i>
<p>Robins, chickens, moths, butterflies, toads, and mammals all have young. Animals grow and develop. Animals eat different kinds of food and live in different kinds of places. Animals are affected by the seasons.</p> <ol style="list-style-type: none"> 1. Animal activities in the spring. 	<p>Animals are able to survive the changing seasons.</p> <ol style="list-style-type: none"> 1. Insects 2. Spiders 3. Fish 4. Birds 5. Amphibians 6. Reptiles 7. Crayfish 8. Mammals 9. Earthworms <p>Animal tracks may tell a story.</p>	<p>Animals are protected in many ways.</p> <ol style="list-style-type: none"> 1. Some animals migrate. 2. Some animals hibernate. 3. Birds care for their young. 4. Some animals are protected by their structure. 5. People help protect birds and pets. 6. People are protected by clothing and shelter. 7. Each animal is fitted to the kind of place in which it lives.
<p>Plants are affected by the seasons.</p> <ol style="list-style-type: none"> 1. Plants in spring. 2. The bean cycle. 	<p>Plants are able to survive the changing seasons.</p> <ol style="list-style-type: none"> 1. Trees are plants. 2. Seeds are scattered in many ways. 3. Bulbs have stored food which helps them to grow. 4. How seeds grow. 5. How wild flowers survive. 	<p>Plants are protected in many ways.</p> <ol style="list-style-type: none"> 1. Some trees lose leaves and have winter huds. 2. Plants produce new plants in different ways. 3. Plants need soil and water. 4. People help protect wild flowers. 5. Plants need a favorable climate.
<p>A home for water animals.</p>	<p>How to make terraria for caterpillars and spiders. How to make an aquarium.</p>	<p>How to make a terrarium for snails. Aquarium vs. terrarium.</p>
<p>Rivers are enlarged in spring. Heat makes water go into the air. Rain comes from clouds. A thermometer shows how hot or cold the weather is. Wind is air that is moving. Weather changes. Rainbows are made when the sun shines on rain. Rainbow colors may be seen in several places. Fire needs air to burn. The wind, sun, and water affect rocks.</p>	<p>Weather changes. Weather in many places. We read a thermometer above or below zero. Water</p> <ol style="list-style-type: none"> 1. Evaporation and condensation. 2. Different forms. 3. Effect of lack of water. <p>How clouds are made. Animals and fire need air. The weather vane tells what kind of wind is blowing.</p>	<p>Day and night are caused by the rotation of the earth. Thermometers have many uses. Rainbows</p> <ol style="list-style-type: none"> 1. Sunlight makes rainbows. 2. Sunlight has all colors in it. <p>Air</p> <ol style="list-style-type: none"> 1. Air takes up space. 2. Air has pressure. 3. Air expands when heated.
<p>The sun gives heat and light. Colors are in the sunlight. The sun and stars are always shining. Stars are far away. Stars make pictures in the sky. We can tell directions by the sun and stars.</p>	<p>The moon seems to change in size and shape. Star pictures—Big and Little Dippers, Orion, Milky Way The North Star is part of the Little Dipper. The North Star helps us tell directions.</p>	<p>The causes of the moon phases. Constellations—Cassiopeia, Dippers, Orion Relative sizes of sun, earth, and moon. The needle of a compass points north. A compass helps us tell directions.</p>
<p>Rivers and mountains are part of the earth's surface. We put soil into an aquarium. Seeds need good soil to grow. There are different kinds of rocks.</p>	<p>Tree roots are in soil. Some things dissolve. Some do not. Some things form crystals. Soil holds water that plants use. Caves are made in the earth. The earth is round like a ball. The earth has gravity.</p>	<p>How trees use water from the soil. How soil is made. There are different kinds of soil. How soil is carried. Fossils. Different kinds of rocks have different names.</p>
<p>The wind helps things fly. A magnet will pull things made of iron. Electricity makes some things move.</p>	<p>The sun helps living things grow. The wind does work. A magnet has N and S ends. Electricity makes heat and light.</p>	<p>Heat breaks up rocks. The wind does work. Air pressure can be made to work for us. Lightning is electricity.</p>
<p>Some things float. Some things do not float.</p>	<p>Boats float.</p>	<p>Our ears help us hear sound. A thing must vibrate to make sound.</p>
<p>An engine is a machine. Engines do work.</p>	<p>Windmills do work for us. A seesaw does work. Engines help move airplanes. Wheels make work easier.</p>	<p>Levers make work easier.</p>
<p>Living things must have proper care to grow. Proper clothing protects our health. We breathe through our noses. Wash hands to get rid of germs. Germs may make one sick. Cleanliness with food at the seashore. Indoor and outdoor play. Rest after play. Early to bed. Robins, chickens, rabbits, toads, butterflies, moths, and mammals all have young that grow up to be like their parents.</p>	<p>Sunshine helps plants and animals to grow. Seasonal clothing. Care of teeth. Soap and water for cleanliness. What to eat. How to eat. How to stand and sit erect. Play out of doors. How to put out a fire. Insects, plants, amphibians, reptiles, crayfish, squirrels, and birds all have young.</p>	<p>Our bodies need good food, fresh air, and sunshine. Wool, cotton, silk. Eyes, ears, nose, mouth, teeth, skin. Care of skin. Milk and vegetables. Value of good posture. Vacation fun. 8 o'clock for eight-year-olds. Quarantine. How to cross a street. Insects and birds lay eggs. Young mammals are born alive.</p>

WE SEE—A PRE-PRIMER IN SCIENCE

THE PLAN OF THE BOOK

WE SEE is designed as a pre-primer in science. Through the use of pictures it attempts to fix certain science concepts which are in the average six-year-old's experience. Since many children may not have had some of their experiences formulated into words, the teacher will have to help them by directing their activities.

The concepts to be developed, the suggested questions which may be asked, and the information which the teacher will need for her background are outlined for each page in the text.

PROBLEMS PRESENTED IN WE SEE

	Pages in <i>We See</i>
PROBLEM I Of what is the earth made?	2, 3
II How are days different?	4, 5, 6, 7, 8, 9
III How are day and night different?	10, 11
IV How do we know the seasons?	12, 13, 14, 15
V How are living and non-living things different?	16, 17
VI How do people prepare for winter?	18, 19
VII How can we keep well?	20, 21 (Also im- plied in other pic- tures throughout book)
VIII How shall we keep safe?	22, 23
IX How can we help care for animals in winter?	24, 25
X How does electricity help us?	26, 27
XI How do magnets work?	27
XII How do we use air?	28, 29
XIII What makes rainbows?	30, 31
XIV How do squirrels live and grow?	32, 33, 34, 35
XV How do ducks live and grow?	36, 37, 38, 39
XVI How do turtles live and grow?	40, 41, 42, 43
XVII What foods do animals eat?	44, 45
XVIII How do seeds grow?	46, 47, 48

ACTIVITIES USEFUL IN DEVELOPING
THE CONCEPTS PRESENTED

IN

WE SEE

THE EARTH

Pages: 2-3

Concepts to be developed from the pictures through the use of the pictures:

We live on the earth.

We can stand on the land.

We can see land and water.

Boats can sail on the water.

Air is around us.

Clouds are in the air.

Birds can fly in the air.

Airplanes can fly in the air.

We can see farther if we climb a hill.

If we are in an airplane we can see farther still.

The land and the water are farther than we can see. They go on and on.

The air is farther than we can see. It goes on and on.

An airplane flies farther than we can see.

The earth is very, very large.

The earth is land, water, and air.

Questions which the teacher might ask to develop these concepts:

What are Bob and Father doing?

Why are they on the hill?

What can they see?

Could they see as far if they were not on the hill?

Could they see farther if they were in the airplane?

What are Bob and Father standing on?

What is the boat sailing on?

What are the birds flying in?

What else can you see on the land?

Can you think of anything else that could be on the water?

What can you see in the air besides the birds and the airplane?

Information which may be helpful in developing the concepts:

Before this lesson is taught, a discussion should be held out of doors, either at recess or at some time set aside by the teacher. The sky, roads, grass, and other things to be seen should be discussed. The teacher should bring out such facts as: the land is under their feet; trees and other plants grow in the ground; birds and airplanes fly in the air; boats sail on water; water birds swim in water and float on it.

Children need to identify themselves with the earth as they see it around them before they can begin to think of it as a ball. After discussing what they can see from where they stand, if they can go to a higher place such as a hill or an upstairs room and note how much farther they can see, it will help to develop a concept of distance. Then in imagination the teacher can take them up in an airplane and see that the area of the earth seen by the eye increases in dimension. The children are now ready for the picture lesson in the book.

FOGGY DAY

Page: 4

Concepts:

Days are not alike.

Some days are foggy.

Fog is wet. It is hard to see through fog.

Fog is a cloud on the ground. It looks gray.

Suggested Questions:

What kind of day do you think this is?

What is in the air around Bob?

How can you tell that it is foggy?

Have you ever been in a fog? How does it feel?

Have you ever seen fog in the sky?

What do you call fog that is in the sky?

Information:

That there are different kinds of days is the first concept necessary to an understanding of weather. The children should notice the weather for several days, and discuss how one day differs from another.

If fog isn't common in the region, some experience like being in the bathroom, laundry, or kitchen when the air is saturated, should be called to their minds. Be careful not to use the term, *steam*, since steam is invisible. Many people call the cloud that they see coming out of the teakettle, steam. Actually this cloud is tiny drops of water that have condensed. The steam is in the space between the spout and the cloud and is the gaseous form of water. The cloud is similar to a fog, which is merely tiny drops of water suspended in the air close to the ground.

If a child has been in the mountains, he may have gone through a cloud and know that it is the same as a mass of fog.

Fog dims lights because the drops of water scatter the light rays instead of allowing them to continue to our eyes. Since we see objects only because the light from them comes to our eyes, all objects appear dimmed in a fog. Fog acts like a screen.

SUNNY DAY

Page: 5

Concepts:

Some days are bright and sunny.

The sky is blue on a sunny day.

The sun tans our skins and makes us warm.

Animals like to lie in the sun.

Suggested Questions:

What kind of day is this?

How do you know that it is a sunny day?

How does the sky look to you on a sunny day?

What colors are in the sky on a sunny day?

What does the sun do to your skin when it shines on you?

How does it make you feel?

What are the animals in the picture doing?

What do you like to do in the sunshine?

Information:

In contrast to a foggy day, the air on a sunny day is either dry or contains only invisible moisture. Objects appear distinct and brightly colored. The sun's rays, when they strike objects, cause them to become warm. Light rays are not heat rays but they cause the molecules in objects to move faster. The motion of the molecules is what we call heat.

Have the children touch objects in the sunlight and in the shade and feel the difference. Feel different kinds of substances such as metal, wood, grass, and glass, to compare the effect of sunlight upon them.

SNOWY DAY

Pages: 6-7

Concepts:

Some days are snowy.

Animals find protection from snow in woods and under bushes. We can tell what animals have been doing at night by their tracks in the snow.

Some days we have frost.

Suggested Questions:

How do you know what kind of day this is?

What are the animals doing?

In what ways are these animals protected from the cold?

How are you protected from the cold?

Can you read the story told by the tracks in the snow? Which animals made them?

Information:

Children who have never seen snow may have difficulty with the concepts of a snowy day. Some of the frost from around the freezing unit of a refrigerator will help give an idea of the texture of snow.

Snow is not frozen rain but frozen water vapor, formed much as the frost in the refrigerator is formed. That is, the invisible water vapor in the air, instead of condensing to make drops before freez-

ing, changes directly to tiny crystals of ice which congregate around dust particles in the air to make snowflakes.

The tracks in the picture are deer and rabbit tracks. The ever-greens are pine trees.

RAINY DAY

Page: 8

Concepts:

Some days are rainy. The sky is gray.

Rain falls from the clouds.

We need the rain. Other animals need the rain.

Little toads leave ponds on rainy days and move to gardens and fields. Since they need to keep their skins wet, they move on a rainy day or at night so the sun will not dry them out.

Suggested Questions:

What kind of day is this?

What are the animals doing?

Why are the toads leaving the pond?

Do you know where the rain comes from?

Why do we need the rain?

What other things in the picture need rain?

Information:

A rainy day differs from a foggy one in that the cloud, higher up in the air, has grown too heavy to be held up by the air. The drops are larger than fog droplets and no longer suspended.

Little toads leave a pond on a rainy day to migrate to a garden or field. They have spent their tadpole stage in the water, but as adults they will live on the land. Since toads are amphibians, they get part of their air through their skins, so they must keep their skins moist or air can't be absorbed.

If they migrate on a sunny day, many will die before they reach their destination. Sometimes they migrate at night. Swarms of them moving across wet pavements on rainy days have given rise to the superstition that it rains toads.

Once in a field or garden, toads bury themselves in the dirt during the day or hide under moist leaves.

SUNNY DAY

Page: 9

Concepts:

Some days the wind blows.

The wind blows trees.

The wind makes it hard for us to walk when it blows hard. It also makes it hard for birds to fly.

Wind is moving air.

Suggested Questions:

What kind of day is this?

Can you see the wind? How do you know it is there?

Can you feel the wind against you when you walk?

Can you think of other things the wind does?

Information:

Wind is the first experience most children have with air as a real substance. Let them run on a day when the wind isn't blowing, to feel the "wind" they make. They can also feel the resistance of the air.

After coming indoors let them wave their hands briskly. Have them breathe deeply to feel the motion of air through their nostrils. Also let them blow bits of paper, feathers, or plumed seeds.

Discuss the fact that they are causing small amounts of air to move. These are like little breezes. On the other hand, wind is a large amount of air moving.

DAY AND NIGHT

Pages: 10-11

Concepts:

The sun shines all the time.

In the daytime our side of the earth is toward the sun.

Even on cloudy days the sun is shining. We can't see it because of the clouds.

When it is dark it is night.

At night our side of the earth is turned away from the sun.

The moon is bright at night.

Stars shine at night.
We are in the earth's shadow.

Suggested Questions:

How can you tell when it is day?
What is the difference between day and night?
What makes the light?
What makes the dark?
Where is the sun at night?
What do we see in the sky at night?

Information:

Of course, every six-year-old knows when it is day and when it is night. These two pages are to focus attention on the differences and to lay the foundation for the concept that the earth is moving.

Note the position of the sun at different times of day. When speaking of its position, say, "We are turning toward the sun," or "away from it," as the case may be. Notice shadows, mark them, and watch as the shadows of the objects move.

Children very quickly learn the feel of the earth's moving if they do not first get the idea that the sun moves.

A good time to discuss the moon is when it is in the last quarter and still visible through the morning. Take the children out of doors and have them compare the light of the moon with that of the sun. Help them to see that the moon is visible only because the sun shines on it.

Discuss the stars and that they shine as the sun does because they are hot. Compare the sun and stars to a light that is shining. The moon is like a light in a room that is not lighted. We see it only when another light is lighted.

AUTUMN

Page: 12

Concepts:

School starts in autumn.
Leaves change color and fall.
Autumn follows summer.
The days are getting shorter. The nights are getting longer.

Suggested Questions:

- What are the children in the picture doing?
- What is happening to the leaves on the trees? Why?
- What time of year is it?
- What time of year was it before autumn?
- Can you play as late now as you could in summer?
- Is it light as early in the morning now as it was in summer?

Information:

Having learned about different kinds of days, the children are ready to learn the seasons. The names of the seasons are probably familiar to them but few first-graders know their sequence.

Let the children discuss the changing weather from day to day, and the shortening of the days as winter approaches.

Watch for signs of autumn, such as ripening seed pods, colored leaves, flocking of birds, flight of ducks and geese, caterpillars spinning cocoons, squirrels and chipmunks storing food. Remember that man is the only animal who knows that winter is coming. The activities of other animals are instinctive, or natural. They are similar to the crawling of a baby at a certain stage of its development. It is instinctive for squirrels and chipmunks to store food when an excess is available. Such is the case in autumn.

WINTER

Page: 13

Concepts:

- In winter it is colder than in autumn.
- In the north we have snow and ice.
- Snow and ice are frozen water.
- When the snow melts in the daytime and freezes on trees and roofs, it may make icicles. Icicles are ice.
- The days are short in winter. The nights are long.
- The trees have lost their leaves.
- Winter follows autumn.

Suggested Questions:

- How many things in the picture tell you that it is winter?

What makes the snow?
Where does it come from?
What happens to the snow when the sun shines on it?
Have you ever seen the snow drip off the roof when it melts?
When it is very cold, what happens to the water as it drips?
What is an icicle made of?
What has happened to the leaves in the picture?
Is it light as long in winter as it is in autumn?

Information:

Snow comes from the clouds, just as rain does. However, snow is not frozen rain. Water vapor, high in the air, when cooled to a point below freezing, forms crystals of ice around dust particles. Each snowflake is made of myriads of these needle-like crystals. The crystals are perfect six-sided prisms and are arranged to form six-pointed snowflakes. All snowflakes are six pointed unless deformed.

Children should be allowed to examine the flakes of the first good snowfall. The flakes may be caught in an open window or out of doors. To keep them from melting until they are examined, let the flakes fall on a dark woolen cloth, such as a coat or scarf, and examine them with a hand lens.

If evergreen trees are growing near enough for the children to look at them, notice how the branches hold the snow, without breaking. This is because of the way the branches grow. Compare the trees in the picture and discuss what would happen to the trees that lose their leaves if snow fell on them before their leaves were gone. The weight of snow on the leaves of these deciduous trees would break the branches.

SPRING

Page: 14

Concepts:

Snow melts in the spring.
Buds on trees swell and open.
Flowers on apple trees bloom.
We make gardens in spring.
Spring follows winter. The days are longer, the nights shorter.

Suggested Questions:

What time of year is this?
How do you know it is spring?
Have you ever made a garden?
Why do you make gardens in the spring?
What happens to the trees in the spring?
When will the apples come on the tree?

Information:

Spring will be so far behind when the children begin to study the seasons that they may have difficulty recalling it. Gardening is a familiar spring activity. Bring out the changes in plants and dress of the children in the picture. An activity which will help to recall spring is to have a number of other spring pictures, such as a spring shower, child flying kite, and bird making a nest, among pictures of other seasons. Let the children pick out the spring pictures. Perhaps the children can recall some interesting things they did last spring, such as planting gardens, picking flowers, or watching a bird build its nest. Perhaps they can remember that snowsuits were discarded when spring came.

SUMMER

Page: 15

Concepts:

The sun is warm in summer.
Trees have green leaves in summer.
We like to go swimming and fishing in summer.
Summer follows spring.
Days are long, nights are short in summer.

Suggested Questions:

What kind of weather is shown in the picture?
What is the family doing?
What do you do when you go on a picnic?
What time of year is shown in the picture?
How many things in the picture tell you that it is summer?
What are some other things you do in summer?

Information:

Encourage children to recall their summer vacations and tell some of the things they did. Compare the trees in the picture with the trees shown in the pictures of the other seasons. Also compare the clothes of the children in the different pictures.

LIVING AND NON-LIVING THINGS

Pages: 16-17

Concepts:

Some things on the earth are alive, some are not alive.

Plants and animals are alive.

Rocks, soil, and water are not alive.

Trees, shrubs, weeds, grass, and wild flowers are plants.

Children, dogs, birds, chipmunks, and butterflies are animals.

Living things breathe, eat, and grow.

Non-living things do not breathe, eat, or grow.

Suggested Questions:

How many things that are alive do you see in the picture?

How do you know that they are alive?

Which ones are animals and which ones are plants?

Can you find three things that are not alive?

How do you know that they are not alive?

Find something near you that is not alive.

Information:

Before looking at these pictures, the children should discuss the things in their room that are alive. Let them name all the things they can see that are not alive. Let them tell how they know live things from things that are not alive.

The things in the picture that are alive are the children, dog, chipmunk, birds, trees, grass, flowers, and butterflies. The things that are not alive are the rock, basket, stones in the basket, clouds, soil, and the clothes of the children.

Children may say that living things move and that non-living ones do not, but a plant moves only through growth. Try to bring out that living things feed and grow.

PREPARING FOR WINTER

Pages: 18–19

Concepts:

People, unlike other animals, know that winter is coming.
They prepare for the colder weather by storing food and fuel.
They store food for domesticated animals.
They make repairs on buildings and insulate them.
They buy warm clothing.
They get out stored winter clothing and bedding.

Suggested Questions:

What are the people doing?
Why are they doing these things?
How does your family prepare for winter?
Did your mother do anything in the summer to get ready for winter?
What are the birds in the picture doing?

Information:

These pages should help fix the concept that people know that winter is coming and prepare for it. The birds are migrating by instinct.

HEALTHFUL LIVING

Page: 20

Concepts:

We should wash before eating and after going to the toilet.
We should bathe each day.
We should brush our teeth after each meal.
We should have regular times to go to the toilet each day.

Suggested Questions:

Why should you wash your hands?
When are the most important times to wash them?
How often should you take a bath?
What is the best way to brush your teeth?
Why is it important to go to the toilet at regular times?

Information:

Make it possible for the children to look at dirty hands with a hand lens. Discuss the germs that are in dirt, as a reason for washing hands before eating and after going to the toilet; also for not putting pencils, fingers, and other dirty objects into their mouths.

Demonstrate the correct way to use a toothbrush, starting at the gums and brushing toward the biting edges, both inside and outside.

Make sure that the children understand the importance of regular toilet habits as a means of eliminating wastes from their bodies, which might otherwise make them ill. Teaching children the reasons for health habits does more good than merely repeating rules or learning health rhymes.

HEALTHFUL LIVING

Page: 21

Concepts:

We must eat good food to be well and strong.

Mother buys good food for us to eat. Fruits and vegetables are good food.

Suggested Questions:

What are some of the things you eat to keep you well?

If you were shopping with your mother, what would you choose to put into your market basket?

What do you think your mother would choose?

What are some of the things you should eat each day?

What do you drink with your meals?

Information:

If possible, have a basket of fruits and vegetables and let the children choose what they would buy. Visiting a market and discussing the food they need each day would be a profitable activity.

If the children eat lunch at school, help them choose balanced meals. Every six-year-old child needs to include at least the following in his daily diet:

1 quart of milk
1 serving of cereal
1 egg
1 serving of enriched bread at each meal
1 serving of citrus fruit or of tomatoes
1 serving of other fruit—fresh, canned, or dried
1 or more servings of potatoes
2 or more servings a day of vegetables other than potatoes, one of them green or yellow
1 serving daily of meat, fish, or poultry, often two
Butter or fortified margarine, that is, with vitamin A added
Fats and sugar to complete the energy requirements

SAFE LIVING

Page: 22

Concepts:

Always stop when you come to a crossing.

Look to the left. If no cars are coming, walk to the center of the street. Stop! Look to the right. If no cars are coming, walk to the sidewalk.

If the crossing has traffic lights, cross when the light is green. If the light is red, wait.

Never run into a street or across a street.

Suggested Questions:

How did Bob and Susan know when to cross the street?

How do you cross safely?

If there were no lights, what would you do to make sure you were safe?

Why should you walk and not run across the street?

Information:

Since not all children have stop signs to help them, the teacher should stress the method of crossing to be used in that particular locality. These rules should be followed by every pedestrian, for safety.

1. Cross streets and highways only at recognized crossings, not just anywhere.
2. On country roads or highways, walk on the left side of the road, facing traffic.
3. Do not run across the street because neither you nor the driver of a car that might appear suddenly will have time to react.
4. Never dart into the highway from behind parked cars or other objects.

Many primary rooms have model traffic signals which are used for teaching children correct habits of street crossing. A better way is to go with the children when they cross a street and teach them at the crossing.

SAFE LIVING

Page: 23

Concepts:

Always play in a safe place.

Do not coast or skate down a driveway that leads into a street. If a car were coming, you might be hurt or cause the car to have an accident.

Suggested Questions:

Why are the marks on these pictures?

Where should these children have been playing?

Where can you skate or coast safely?

What might happen to the car in the picture if the children should coast or skate into the street?

Information:

Many children are killed by doing the things marked with X on the picture. Adults are at fault for not providing safe places for children to use their scooters, wagons, roller skates, and tricycles.

In teaching this safety lesson, stress should be put on safe places to play. Stress should also be placed on the fact that the children are not only endangering themselves but others, when they play in the street.

WINTER FEEDING OF ANIMALS

Pages: 24-25

Concepts:

In winter, birds and other animals have difficulty finding food. We can help by putting out food and water.

We can put our Christmas trees outdoors with food on them.

Seeds, berries, and suet are good food for birds.

Squirrels will eat almost anything, but they like nuts, bread crumbs, and seeds.

We should keep water on the feeding shelf, also, since the natural supply of water freezes.

Suggested Questions:

What time of year is it?

Why is the food on the birds' Christmas tree?

Who put the food on the tree?

How many different kinds of food can you find?

What birds will eat the food?

What other animals can you feed in the winter?

What else do the animals need besides food?

Can you think of ways that you can help feed birds and squirrels in winter? How would you do it?

Information:

In cold climates, bird feeding is one of the easiest ways to introduce bird study. It is hard for a little child to observe a bird in a tree, but when birds come to the window sill where the details of color, shape, and size can be observed, interest is keen. A simple homemade shelf works as well as a more elaborate one. A hard doughnut, hung from a tree branch near a window, will attract nuthatches, chickadees, and other insect-eating birds. Suet or other fat meat will attract them also.

Cardinals and other grosbeaks like seeds, fruit (even apple cores and cranberries), but will also come for doughnuts and crumbs. Ground birds, such as the pheasant and quail, will eat corn or any other grain.

Once birds start coming to a feeding station, you will always have them. Don't forget to put out water, especially in winter.

ELECTRICITY

Pages: 26-27

Concepts:

We use electricity in our homes.

Electricity gives us light. It runs sweepers, washing machines, and sewing machines.

To turn on lights we use a switch. A switch is used to turn on any electrical appliance.

Some pieces of iron can pull other pieces of iron. They are called magnets.

Iron is a metal. It is hard and black.

Steel has iron in it.

Magnets are usually made of steel.

Magnets will pull anything made of iron or steel.

Suggested Questions:

What are some of the things that Bob and Susan got for Christmas?

What is Susan doing?

What makes the lights go on?

How many things that use electricity can you see in the picture?

How would Susan make the train go?

What is Bob playing with?

Have you played with a magnet?

What does it do?

What is it made of?

What are the things made of that a magnet pulls?

Information:

Most modern children take electricity for granted, but they often wonder why pushing a button makes a light go on or off. Children begin to learn about electricity when they use electrical appliances. The teacher should let children learn how to plug in an electric plate, movie machine, Christmas tree lights, or other appliances used in the room. She should be sure that the plugs and sockets are in good condition. She should teach the children to always have dry hands when handling electrical appliances and to never

touch the inside of a socket with their fingers. They should always hold a plug by the insulated part.

In the picture Susan has just pushed a switch to turn on the Christmas tree lights. Other electrical appliances in the room are lamp, radio, train, and vacuum cleaner. Bob is playing with a magnet.

Children should be allowed to play with magnets and to discover that they attract things made of iron or containing iron, such as steel. Permanent magnets are made of steel.

AIR

Pages: 28-29

Concepts:

Air is all around us. We can't see it nor smell it. We can feel it when we run or when the wind blows.

Air holds things up. It holds up balloons, birds, and parachutes. Air is lighter than water.

An inner tube, ball, or anything filled with air floats on water.

We breathe air. All animals breathe air.

Fire needs air to burn. Men put out fire by shutting out the air.

Suggested Questions:

Every person in the picture is using something that you can't see. Can you figure out what it is?

Can you find other ways in the picture in which air is being used?

How is it being used?

What have you learned about air?

How is the man in the picture putting out the fire? How would you put out a fire?

What makes a fire burn?

Why do things float?

Information:

Every person in this picture is demonstrating some property of air. Before looking at the picture the children should have some experiences with air. Try floating different objects in water, such

as a rock, a dry sponge, cork, and a small corked bottle. Squeeze the sponge under water and notice the air bubbles come out as the sponge sinks. Uncork the bottle and watch the air come out as it sinks. This last experiment not only teaches the concept that air is lighter than water, but gives a more concrete idea of air as a substance.

About this time also, a child should discover that fire needs air to burn. If the children make lanterns of pumpkins they will find that the candle goes out if the lid is put on the lantern.

All experiments using fire must be done carefully on a metal tray, with all inflammable materials removed from the table.

RAINBOWS

Pages: 30-31

Concepts:

Sometimes we see colors in the sky.

When the colors are in the shape of a bow, we call them a rainbow.

We see rainbows when the sun is shining on the rain.

We see the colors of the rainbow in the fine spray from breakers, sprinklers, or waterfalls.

Sometimes we see colors in the clouds.

The colors of the rainbow are red, orange, yellow, green, indigo, blue, violet.

Suggested Questions:

What do you often see in the sky when the sun comes out after a rain?

Why is it called a rainbow?

What colors do you see?

What makes the colors in the rainbow?

Do you see the rainbow colors in the picture on page 31? Why isn't the bow a real rainbow?

Have you seen rainbow colors in other places?

What makes the rainbow colors in water from sprinklers, waterfalls, and sprays?

Information:

Rainbows fascinate children because they seem mysterious. They come suddenly and go just as quickly. Six-year-olds are too young to understand the principles involved in the splitting of white light to make the spectrum. The spectrum is the band of colors that combined, make white light. The children should, however, begin to notice the many places where colors are produced by this phenomenon. They can observe that one sees a rainbow only when the sun is behind him and the rain in front of him. They can also learn that rainbow means a bow made when sun shines on rain. The colors in spray are really "spray" bows, though we may call all spectra made by water drops in the air, rainbows.

Use differently-shaped pieces of glass, beveled-edged mirrors, or a prism to produce a spectrum on the wall. Discuss the color of the sunlight on the wall without the prism in its path, and with it. If the wall is not white, hold a piece of white paper in the spot of light. Merely try to teach the concepts that sunlight looks white, but when it passes through water drops or edges of glass, we see the white light break up into colors. The indigo band fuses with the blue and is hard to see.

The corner of an aquarium separates the colors in white light just as a prism does. The colors in the sky and clouds are caused by the same phenomenon.

SQUIRRELS

Pages: 32-33

Concepts:

Female fox squirrels make nests of twigs and leaves. They make them in late autumn. The nests are firmly woven and lined smoothly with large leaves.

The squirrel enters the nest through a small hole.

When the nest is finished, it is tight and weatherproof.

The inside is lined with soft bark and plant fibers.

Sometimes the nest is made in a hole in a tree.

In autumn squirrels store food in holes in trees or in the ground.

Suggested Questions: (Page 32)

What time of year is it?
What do you think the squirrels are doing?
Why are they making a nest?
What is the nest made of?
How do the squirrels get into the nest?

Suggested Questions: (Page 33)

What time of year is this?
What is the squirrel doing?
How does the squirrel keep warm?
Can you tell what the nest is made of?

Information:

These are the first pictures in animal life cycles, to give children an overview of the principle that will be developed more and more in detail as they grow older. The principle is: all life comes from life and produces its own kind.

The squirrel illustrates the life cycle of a typical mammal—that is, a fur-bearing animal that feeds its young on milk.

Different species of squirrels vary some in their habits, so the teacher should use the kind commonly found in her vicinity for concrete experiences, before the children study the pictures. Then they can compare the squirrel of the picture with the kind they know.

Some squirrels make their nests in holes in trees. Many of them make summer nests of leaves, and winter nests in holes. The young are born in the winter nests in late winter or early spring.

Pages: 34–35

Concepts:

In the spring three or four little squirrels are born.
The little squirrels have their eyes closed and haven't much hair when they are born. They are very helpless.
Their mother feeds them milk from her body.
In a few weeks the little squirrels are large enough to come out of the nest. They play in the sunshine and nibble the buds on the trees.

Suggested Questions: (Page 34)

When are young squirrels born?

How many does the mother squirrel usually have?

How are the little squirrels different from their mother when they are born? Can they run around with her?

Do they have bushy tails?

How do they keep warm?

How does their mother feed them?

Information: (Page 34)

The teacher should bring out the fact that the little squirrels are helpless when born, also that they are mammals. If children ask about how little squirrels are born, a simple answer such as that they come out of an opening in the mother's body usually satisfies their curiosity. In schools where sex education is not taboo, these life cycles are good means of bringing to the surface any questions that may have been in the children's minds concerning sex. They should be answered directly, simply, and truthfully. Then no undue importance will be attached to sex. The next remark from a child may be, "Aren't they cute?" or "How do they get fed?"

Suggested Questions: (Page 35)

How old do you think these little squirrels are?

What do they eat now?

Where do they sleep?

Do they look like they did when they were born?

Information: (Page 35)

Little squirrels stay in the nest until they are able to climb without falling.

When they first venture out, some may be more independent than others.

By this time they are losing their milk teeth. All young mammals have temporary teeth just as human babies do. At this stage the squirrels will be gnawing on young buds and the tender bark of twigs.

Caution children not to catch any young squirrels that they may

see, but to watch them. Sometimes the mother is killed and the orphans may be adopted by the teacher and children. Milk that is fed to such small mammals must be diluted with warm water. A drop of condensed milk to a teaspoonful of warm water is about right for squirrels.

As soon as the squirrels have teeth, they need to gnaw on twigs or nuts. When they begin to come out of the nest, they begin to forage for themselves, but their mother keeps her eye on them until they leave the nest permanently.

Bring out the fact that when the squirrels are grown, they will be like their parents and able to have little squirrels.

BIRDS

Pages: 36-37

Concepts:

Ducks are birds that get their food from the water.

There are many kinds of ducks.

The father duck is called a drake. He has brighter colors than the female duck.

The drake and duck mate in the spring.

The female duck builds a nest on the ground. She lines it with down from her breast.

She lays about a dozen greenish-tan eggs in the nest.

She sits on the eggs to keep them warm.

The drake swims on a near-by pond or lake but pays no attention to his mate.

Suggested Questions:

What kind of birds are these? Are the two that you see on the shore alike?

How can you tell the duck from the drake?

How do ducks get their food?

Are all of the ducks in the picture the same kind?

Is this nest like the squirrels' nest?

How do you think the duck made it?

How many eggs are in the nest?

Where is the nest?

What is going to happen to the eggs?

Information:

Ducks are used to illustrate the life cycle of birds because they are larger and more easily observed than song birds. Bring out the fact that the duck and the drake are different colors.

If possible, the children should watch some live ducks and geese and notice the main characteristics that make them birds, namely, that they are animals covered with feathers and that they have wings and beaks.

The two parts of a bird's beak are called the *mandibles*. A duck has a shovel-like beak with toothed projections on the lower mandible that act like a strainer. Ducks scoop up mud and water with the insects and plants that they eat. The water and mud run out the sides of the beak.

The nest differs from a squirrel's nest in the construction and the location. Birds lay eggs; mammals are born alive.

It is fortunate that birds making their nests on the ground lay more eggs than those nesting in trees. Otherwise, since some of the eggs are often eaten by other animals, there wouldn't be many little ducks. Snakes, weasels, skunks, and other animals eat eggs.

Pages: 38-39

Concepts:

In four weeks the eggs hatch.

Downy ducklings come out of the eggs.

Their down is wet when they first come out of the eggs. They soon dry and their legs become strong.

They do not eat for a while.

As soon as all the ducklings are dry and strong, the duck leads them into the water. Through the day they will follow her, getting insects and other food from the water. By autumn, the ducklings will be as large as their mother.

Suggested Questions:

What is happening to the duck eggs?

Do the ducklings look like the big duck?

What is the difference in the way squirrels and ducks are born?

What is the difference between little squirrels and ducklings when they are born?

How does the mother duck care for the ducklings?

How long will it take the ducklings to grow as big as their mother?

Information:

Many children know that eggs will hatch when kept warm, but they may not realize how long it takes for the little duck to grow inside the egg, or that it has to break the shell to get out. Duck eggs are incubated four weeks and the ducklings are able to run around as soon as they are dry. In a short time they will all be in the water.

Bring out the fact that ducklings are covered with down, while the adults have large feathers. Compare ducks and squirrels in their appearance. Note that ducks hatch from eggs that the mother made in her body and incubated in a nest, while squirrels develop from eggs without shells, that were nourished in the mother's body. Both come out the same way.

Ducklings will be as large as adults by autumn and mature the next spring. They will mate, lay eggs, and have ducklings.

TURTLES

Pages: 40-41

Concepts:

Painted turtles live in ponds and lakes.

They have to come to the top of the water to breathe.

Their feet are fitted for walking and swimming.

Turtles have scales on their bodies. They have shells that cover their bodies.

In June the female turtles leave the water to lay their eggs.

They dig holes in the ground with their hind legs. Several white eggs are laid in one hole.

The female turtles cover the eggs with dirt and leave them.

The sunshine warms the eggs.

Suggested Questions:

What kind of animal is this?

Where does it live?

How does it breathe?

How do its feet help it to live both in the water and on the land?

How is it protected from its enemies?

Where does the female turtle lay her eggs?

Are the eggs like the duck eggs?

Does the turtle sit on the eggs?

How are they kept warm?

Information:

Mammals and birds are warm-blooded animals, meaning that their temperature is constant. All other animals are cold blooded, meaning that their temperatures change with the temperature surrounding them.

Turtles represent the class of reptiles. The children should observe a live turtle and compare it with birds and mammals. Note its covering of scales and shell.

Scales are characteristic of all reptiles. Also characteristic is the fact that they breathe air even though some may live in water. Fish have scales but they can get air from water while turtles have to come to the surface for air.

Some turtles live on land. The box turtle is a common example of land turtle. It can completely draw into its shell.

A small turtle is easily kept in captivity and will become quite tame. Keep it in a terrarium or a cage containing sand. Put a pan of water at one end of the container. Feed it bits of raw meat (slightly tainted), earthworms, or prepared turtle food.

Females sometimes lay eggs in captivity, but unless they have mated before being captured, the eggs will not hatch.

The pictures are of the painted turtle and the concepts given are for that species.

The turtles' feet are webbed and have claws. Turtles are protected by their shells and by hiding in the water.

The female leaves the water to lay her eggs. She digs a hole in the sand with her hind legs, then lays a number of leathery white eggs. She packs the sand above them, and leaves them.

Concepts:

Little turtles hatch from the eggs in September. They still feed on the yolk of the eggs for a while.

Sometimes they stay in the hole all winter.

They look like their parents.

In the spring the little turtles come out of the hole.

They crawl to water to find food.

They eat insects and other small animals that they find in the water.

Perhaps the big turtle is their mother, but they pay no attention to her, and she pays no attention to them.

Suggested Questions:

How long does it take turtle eggs to hatch?

Are the little turtles helpless?

How do they get food right after they hatch?

Does their mother take care of them?

Do little turtles look more or less like their parents than do ducklings or little squirrels?

Where do they stay in winter?

What do the little turtles do in the spring?

Where do they find food?

If the big turtle is their mother, do you think they know her?

Does she know they are her young?

Information:

Little turtles emerge from the eggs fully developed but with the yolk sacs still attached to their abdomens. The yolks help nourish them for several days. They are able to care for themselves as soon as they are hatched. If the weather is cold when they hatch, they may remain in the hole and hibernate.

Hibernation is not the same as sleep. In hibernation the animal's bodily processes are slowed down to a point which barely sustains life. The circulation, breathing, and metabolism are retarded. The blood temperature may be reduced almost to freezing. Hibernating turtles seem dead but if brought into a warm room will slowly "thaw" out and become active.

Water turtles cannot completely close their shells, while land turtles can. Some turtles, such as the snapping turtle, can snap with their hard jaws but they have no teeth. The painted turtles are harmless, and small ones make nice pets.

THE FOOD OF ANIMALS

Pages: 44-45

Concepts:

Animals eat many kinds of food.

We eat meat, vegetables, milk, and cereals.

Some animals eat only plants.

Some animals eat only animal food.

We eat both.

Cows and horses eat plant food.

Bees and butterflies eat plant food.

Spiders and hawks eat animal food.

Some birds, such as woodpeckers, eat insects.

Some, such as sparrows, eat mostly seeds.

Some, such as the humming birds, eat nectar from flowers.

Suggested Questions:

How many different kinds of animals can you find in this picture?

What kind of food do they eat?

How do they get their food?

Can you pick out the animals that eat plants?

Can you pick out the animals that eat other animals?

Find a bird that eats insects.

Find a bird that eats seeds.

Find a bird that eats nectar from flowers.

Information:

These two pages summarize concepts about the food of animals with which many children are familiar. Before using the lesson, the children should observe as many animals as possible and discuss their food.

Watch a dog or cat, a canary or other bird, a cow, horse, or sheep, as it is eating. Notice the kind of mouth and whether or not the

animal has teeth. Also, notice any adaptations that the animal may have that help in getting food. For example, people use their hands, and chickens use their feet.

The animals in the picture have the following ways of feeding. The cow has no upper front teeth but the front part of the upper jawbone is thin and hard. This bone helps her grasp the grass close to the ground. Her rough tongue, which she curls around the grass, further helps pull the grass. Her lower front teeth are sharp and are used for biting. Her back teeth are grinding teeth which she uses in chewing her cud. Cows swallow their food whole, then regurgitate it at their leisure and chew it. It is then swallowed again and digestion finished in the stomach.

The humming bird has a tube-like beak and tongue, which help it suck nectar from flowers. Its wings help it poise above a flower as it sucks. Humming birds eat some insects and feed them to their young but most of their food is nectar.

Hawks have strong, curved claws with which they capture their prey. With their hooked beaks they tear the animal and swallow it whole, later regurgitating the fur and bones. The fur and bones are in a small ball that looks much like a gray cocoon. Hawks' strong wings help them to swoop down and catch their food.

Swallows have wide mouths with which they capture small insects. Their wings help them skim through the air, sweeping it for food.

Robins have pointed beaks with which they get berries and insects, or probe into the ground for worms. They also use their feet for scratching in the ground.

Geese have webbed feet which help them swim to find food. They have shovel-like beaks with which they scoop up grain.

A spider makes a web which it uses in catching its food. After wrapping silk around the captured insect, the spider sucks its blood.

All of these concepts are basic to an understanding of the principle that animals have survived because of certain structural modifications that made it possible for them to exist in their particular environment. The children will not learn the principle until they are much older, but these simple understandings are a part of that larger concept.

Be careful not to teach that the animals have the adaptations in order to eat that way. They are able to eat the food they do because of the type of mouths they have.

GROWING PLANTS FROM SEEDS

Pages: 46-48

Concepts: (Pages 46 and 47)

Seeds grow on plants.
Bean seeds are inside pods.
We can plant seeds in soil.
Little plants are inside the beans.
Water and sunshine make the seeds grow.
Little bean plants grow from the seeds.
The little plants have leaves, stems, and roots.
Flowers grow on the plants.

Suggested Questions:

What kind of seeds do you think the children are planting?
What is in the window box?
What, that is inside the beans, will grow?
What will the bean seeds need to make them grow?
What is the first thing that happens to the seed when it starts to grow? What happens next?
What grows on the stem?
What grows down into the soil?
Why does the plant need roots?

Concepts: (Page 48)

Flowers grow into pods.
When the pods are large and ripe they will have bean seeds in them.
The beans will look like the beans that were planted.

Suggested Questions:

What grows last on the plant?
After the flowers bloom, what happens to the petals?
What happens to the part that is left after the petals fall off?

What grows inside the pods?
When they are dry, what do they look like?
Will these seeds grow?

Information: (Pages 46, 47, and 48)

The growth of a bean illustrates the life cycle of a seed plant from seed to seed. Before using the pictures, the children should have seen a bean plant. If the teacher plans ahead for this lesson, she can have the children plant some lima beans in pots or boxes and watch them grow.

In autumn, bean plants are going to seed in the garden. A plant may be brought into the room and examined. The children should see the roots, stem, and leaves. They should learn that the roots get water for the plant and that the stem carries water to the leaves and flowers.

If beans are planted at the beginning of the term they will have time to bloom and produce pods before this lesson is taught. The children should notice that the flowers make the pods and that bean seeds are growing inside the pods.

To summarize the lesson on cycles of animal and plant life, children should discuss the ways that plants and animals are alike. They are living things. They need food and air. They grow. They reproduce their own kind. They depend on one another for their food and shelter yet are continually vying with one another for these very things. As a result, the stronger ones survive while the weaker ones are destroyed.

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